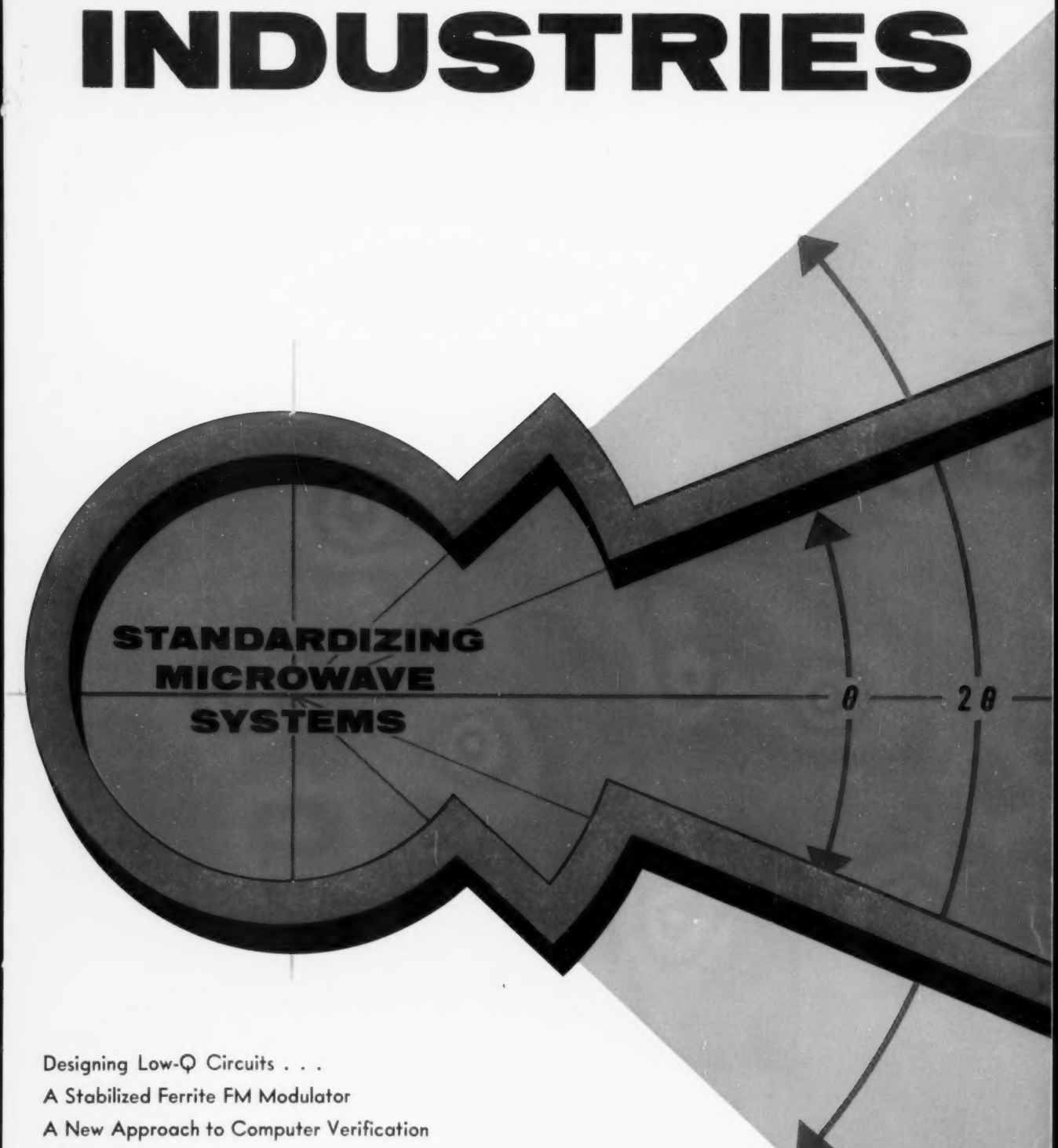
ELECTRONIC INDUSTRIES



Designing Low-Q Circuits . . .

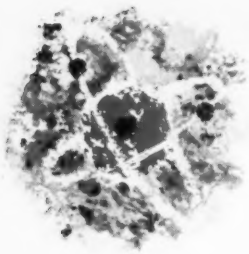
A Stabilized Ferrite FM Modulator

A New Approach to Computer Verification

February • 1958

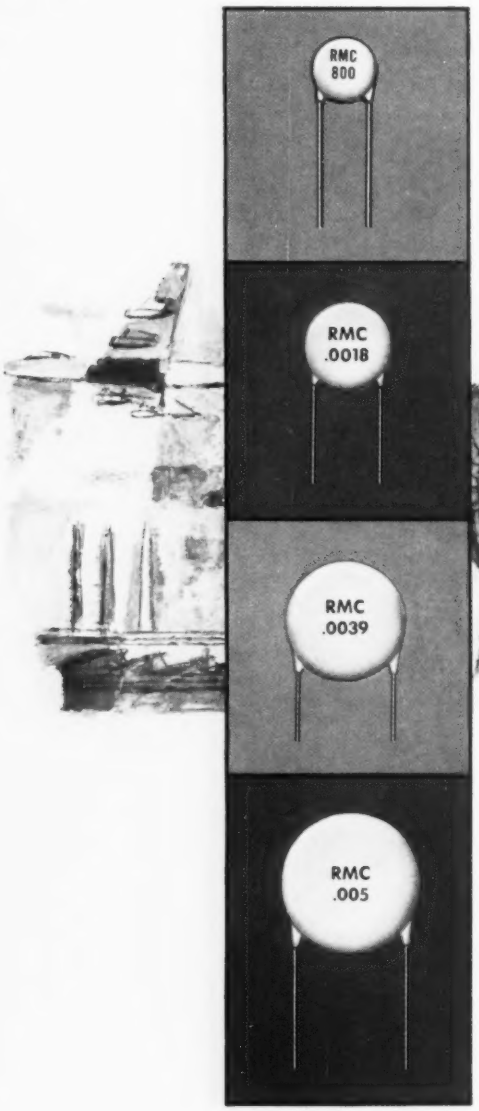
A Chilton Publication

Manufacturing, Design & Operations Edition



temperature stable in every use

RMC TYPE JL DISCAPS



Type JL DISCAPS are especially designed for applications requiring a minimum capacity change as temperature varies between −60° C and +110° C. The maximum change between these extremes is only ± 7.5% of capacity at 25° C.

With a standard working voltage of 1000 V.D.C., Type JL DISCAPS are ideal cost saving replacements for paper or general purpose mica capacitors.

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Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card, page 97

ELECTRONIC INDUSTRIES

Vol. 17, No. 2 February, 1958

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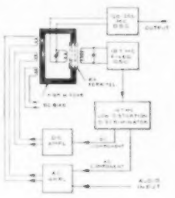
BPA NBP

Microwave Standards 50

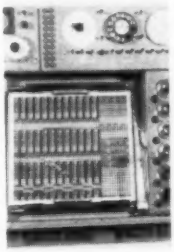
A report on the progress achieved by EIA committee, Microwave Relay Systems for Communication—TR-14, toward standardizing microwave equipment and terminology.

Stabilized FM 56



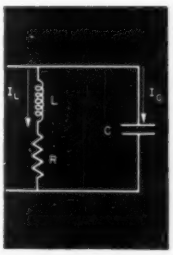
Single-frequency FM modulators can be stabilized by detecting the modulated signal and feeding it back to the reactor.

Checking Computers 62



Point - to - point checking of computer components is prohibitively time consuming. A unique problem analyzer reduces verification time to 40 mins.

Designing for Low-Q 71



Six distinct resonant frequencies enter into the design of a low-Q circuit. Here they are defined and derived.

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RADARSCOPE

SUBMARINE SIMULATOR

Designed to simulate the actions of a real submarine for training potential sub crews this unique device developed by the Electric Boat Co., div. of General Dynamics, dives, turns, climbs, runs into rough weather, fires torpedoes, develops engine failure.

ARE THE EARNINGS of defense contractors excessive? Rep. William E. Hess (R., Ohio) raises the question, and proposes that the renegotiation laws be re-examined to arrive at a specific formula that will determine just whether the earnings of a firm are out of line. Writing in "Planes," the official organization of the Aircraft Industries Assoc., he says that this session of Congress must review renegotiation "to make certain that any artificial barriers to a sound defense program are eliminated, and that the fullest advantage is obtained from our free enterprise system."

TV TEST SIGNALS which were authorized on a test basis by the FCC in April 1957 can now be employed by TV stations until Oct. 3, 1958. The time for filing comments on the proposed rule making proceeding calling for a standard TV test signal has been extended to June 13, 1958.

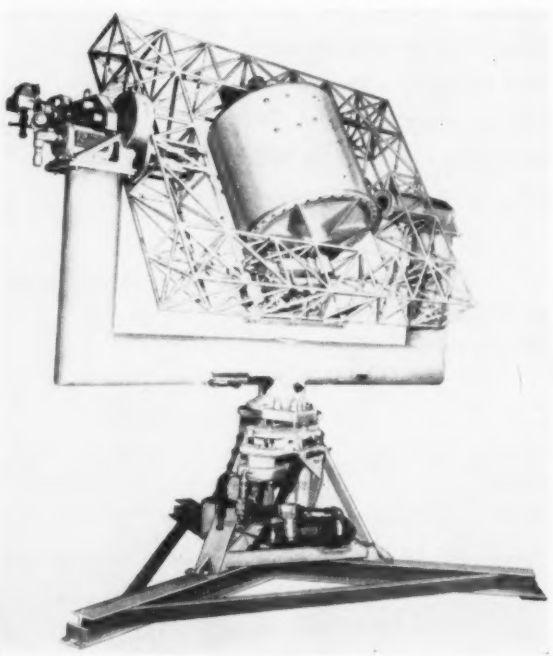
APPLIANCE DEALERS can only hope that a new method of discounting reported in Chicago last month does not catch on. There, seven dealers have signed up to a plan under which the customer calls a certain number to learn the last quoted price on a given appliance. If he is not satisfied with the price he leaves word that he is willing to pay a certain lower figure. The "bid" is then passed on to the seven dealers and if one is interested in meeting the price the deal is consummated.

SMALL BUSINESS PROGRAM of the Defense Dept. is likely to get a drastic overhauling as a result of the scathing report turned in by the Senate Small Business Committee. The report said that "lethargy, inaction and procrastination" were responsible for the lack of progress. The share of awards to small business in fiscal 1957 remained precisely the same as fiscal 1956—19.6%. The heaviest attacks were leveled at the Air Force, whose "true attitude" the committee "finds hard to fathom." The committee said that the Air Force seems indifferent to small business subcontractor casualties resulting from the recent "cutback" and the "stretch-out" adjustments in aircraft procurement.

STEREO TAPES have become the hottest thing in the high-fidelity field. Last year stereo recorders accounted for 50% of the national sales, and stereo recorded tapes accounted for 75% of all recorded tape sold to consumers. In 1958 recorded stereo tapes are expected to ring up a total $8,000,000 in sales and account for 90% of the recorded tape market. These estimates are made by the Magnetic Recording Industry Association. Predictions for the future look to 3,000,000 tape recorders in use in the U. S. by 1960.

3-AXIS FLIGHT SIMULATOR

New simulator designed by Aircraft Armaments Inc. can be programmed to roll, pitch, yaw, and even tumble. Each gimbal is driven by a high performance hydraulic servo system in response to signals from computer. Synchros are used for sensing in the closed servo loop.



TRANS-ATLANTIC TV, live, may be a reality by 1959. Swapping of programs will be accomplished by relaying across the Atlantic land masses, using 60 ft. steel antennas. Pictures can now be sent 200 miles; every effort is being made to send a picture 300 miles —necessary to leapfrog the remote land masses that span the Atlantic.

MUTUAL AGREEMENT reached between the Departments of Commerce and Defense on semi-automatic air traffic control and defense systems has as its objective avoidance of duplicating facilities, equipment, and overlapping functions; increased capability of each function; and, an air traffic control system functionally compatible with the nation's defense facilities in peace and war.

NEWEST METHOD of communication is being tested at Ft. Huachuca, Ariz. It uses infrared beams. Signal Corps engineers have found it possible to modulate an infrared wave and use it for 2-way communications over considerable distances. The infrared beams have the transmission characteristics of light beams —line-of-sight—and would be particularly difficult to intercept. Relay stations on hilltops would be used to extend the range of the systems.

BUSINESS FAILURES during 1957 averaged out to just under 300 per week, a 20% increase over 1956. The final figures for the year are expected to top the 13,619 failures recorded in 1940 and set a new 18-year high. However, the new incorporations in 1957 exceeded failures by ten-to-one.

NIKE-HERCULES missile battalion will begin training very shortly at Ft. Bliss, Texas. Capable of carrying either conventional or nuclear warhead, the Hercules has considerably greater capability in range, altitude, speed and killing potential than its little brother, the Ajax.

INCREASED GOVERNMENT SPENDING on missiles, growing volume of replacement needs, continuing uptrends in research and development outlays, and improved inventory situation promise marked improvement in the American economy, during the second half of 1958, according to Dr. John W. Kendrick, Vice-President, Automation Shares, Inc. The business recession has already begun to level off.

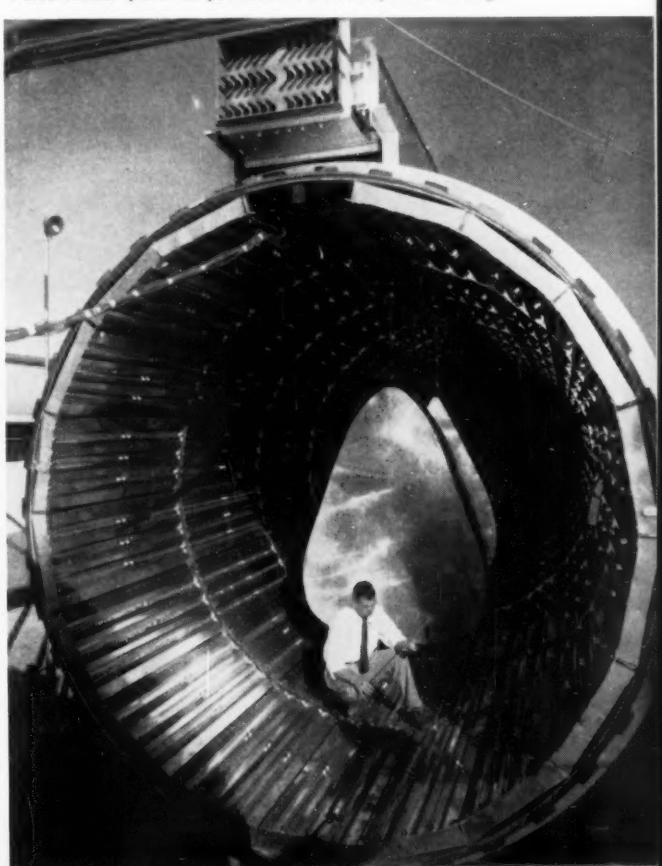
LICENSE FEES to be paid by broadcasting station licensees have been requested in a bill introduced by Congressman Charles A. Vanik (D., Ohio). The income put the FCC on a self-sustaining basis. A similar proposal was made in 1954 . . . no action.

SOLID PROPELLANT ballistic missiles will succeed the Army's Redstone liquid propellant missile when top priority development, directed by Defense Secretary Neil H. McElroy, is completed.

WHILE SCIENTISTS the world over have been concentrating their efforts on a method of attaining the millions of degrees of temperature required to sustain the fusion reaction a small group under Prof. Luis Alvarez at the Univ. of California has stumbled upon the discovery that the same reaction can be made to take place at 400° below zero Fahrenheit. The process depends on the generation of mu-mesons which are, unfortunately, not plentiful in a free state except in cosmic radiation. However a prominent Russian scientist reported several years ago discovering in the cosmic radiation a particle similar to the mu-meson but having a mass about 500 times that of the electron. Four separate projects of the Office of Naval Research are now pressing the search for these particles.

VACUUM TEST CHAMBER

Million-dollar vacuum test stand checks the efficiency of air conditioning and electronics systems in the F-106A Delta Dart all-weather jet interceptor. Jack Loos, thermodynamics engineer for Convair, San Diego, the builders, holds one of the 750 2,500-watt infrared tubular quartz lamps that simulate aerodynamic heating.



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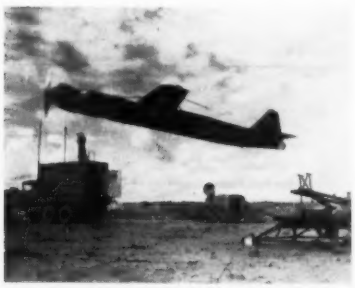
As We Go To Press...

Camera Drone Gives Army Low-Level Photos

Army commanders will get accurate low-level photos of night time combat conditions from a new lightweight reconnaissance camera which can be sent over enemy lines in a pilotless drone. The equipment has been developed by the U. S. Army Signal Corps and the Fairchild Camera and Instrument Corp.

Designated the KA-28, the 17-lb. camera uses 4½ x 4½ in. negatives and is equipped with controls for Image Motion Compensation (IMC).

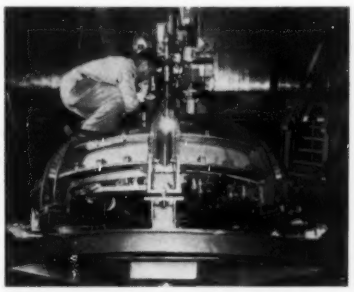


Camera-carrying RD-71 drone aircraft roars from launcher at Ft. Huachuca, Ariz.

The camera has no shutter in the ordinary sense. It makes a series of pictures, one after another, using its own automatic flare ejector to light up the scene below.

The Army feels that the drone will be extremely difficult to intercept or shoot down since it flies in darkness at comparatively low altitudes.

ICBM FUEL TANK



Special jigs hold the "orange-peel" sections of the Titan fuel tank as they are automatically joined by Heliwelding, an inert gas arcwelding process. Air Reduction Co. designed and engineered the fixtures.

NRL Sent AM Signal To Moon and Back

Military security has been relaxed on the details of a 1952 Naval Research Lab experiment which saw amplitude modulated signals transmitted to the moon and back.

The experiment, conducted under James H. Trexler of NRL, used an ordinary airport traffic control transmitter and receiver and a 1-acre wide parabolic antenna dug into the earth. Power output was 100 w. and the antenna had a gain of 40.

Transmissions were made on a frequency of 40 MC with a bandwidth of 10,000 cps. There was reportedly little discernible distortion in the returned signal.

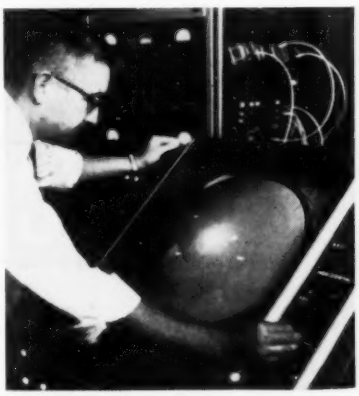
The echo time was 2.6 seconds.

The special antenna, which was constructed at the NRL location, Anacostia, was pointed directly upward.

New Radar Shows Plane's Identity

An air traffic control system designed by Stromberg-Carlson around their Charactron tube simultaneously displays radar or TV images with identifying letters, numerals and symbols that indicate the craft's identity, types, destination, position and the like.

The new C19Q tube uses the intervals between radar pulses to form character displays that appear next to the "blip" of the plane contacted. The tube can show characters at the rate of 50,000 per second.



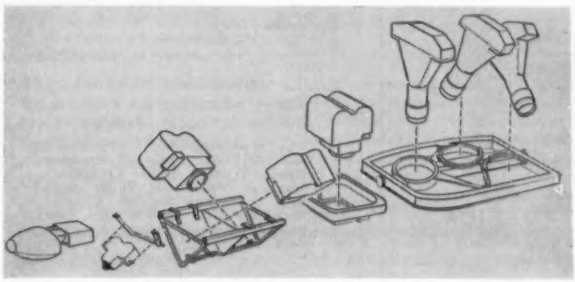
New tube identifies aircraft by flashing symbols alongside "blip" shown on scope

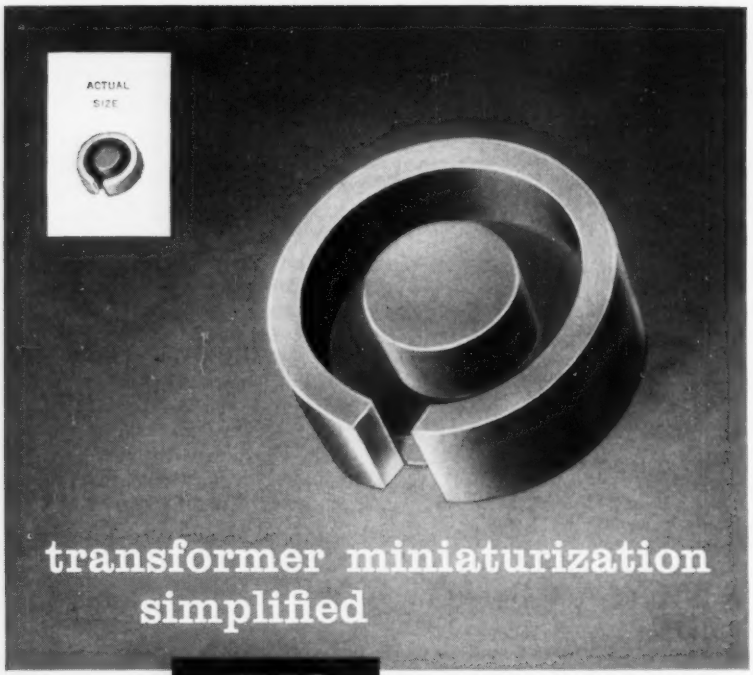
In operation the tubes would be used in a series of consoles, each one displaying different geographic areas and operating independently of each other.

More News On Page 10

NEW PHOTO-RECON SYSTEM

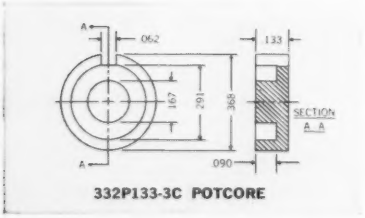
Fairchild Camera & Instrument Corp. designed a highly compact, lightweight camera system for the reconnaissance version of the Convair B-58 supersonic bomber. Camera installations are shown at left, and location right.



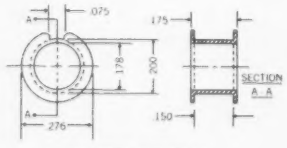


with **FXC** *micro-miniature* **potcores**

Made of Ferroxcube 3C material, the No. 332P133-3C potcore by FXC is less than 3/8" in diameter and successfully eliminates pulse transformer problems created by limitations in weight and space. The coils for this potcore are wound on a specially designed nylon bobbin. The shape of the potcore, combined with the high-permeability material surrounding the windings, gives excellent shielding and effectively minimizes stray fields. The potcores can be placed close together or even stacked, with negligible coupling between coils.



332P133-3C POTCORE



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INDUSTRO TRANSISTOR

PNP Germanium Alloy-Junction Transistor Specifications

INDUSTRO TRANSISTOR TYPE	MAX. RATINGS @ 25° C			TYPICAL CHARACTERISTICS @ 25° C — V_{CC} = −6 volt, I_E = Ima except where otherwise noted										
	V_{CE} Max. (Volts)	Dissipation Coefficient In Air °C/mw	Dissipation Coefficient With Ht. Sink °C/mw	** Beta @ 270 Cycles	Rise Time (μsec) Avg.	Rise Time (μsec) Max.	Storage Time (μsec)	Fall Time (μsec)	$F_{\alpha cb}$ (mc)	C_C (μμf)	D.C. Current Gain Conditions	D.C. Current Gain Gain	I_{CBO} (μa)	Application
COMPUTER TYPES														
2N315	— 20	0.4	0.18						5	12	I_C=100ma V_{CE}=.15V	20	1	Switching
2N316	— 20	0.4	0.18						12	12	I_C=200ma V_{CE}=.2V	30	1	High Speed Switching
2N317	— 20	0.4	0.18						20	12	I_C=400ma V_{CE}=.2V	30	1	High Speed Switching
2N398	—105	0.36	0.15							35			6	High Voltage Switching
2N404	— 25	0.4	0.18						4	12	I_B (ma) / V_{CE} (volts)		1	Medium Speed Switching
2N425	— 20	0.4	0.18		0.5	1.0	0.25	0.3	4	12	1 / .25 10 / .35	30 18	1	Medium Speed Switching
2N426	— 18	0.4	0.18		0.5	0.55	0.25	0.3	6	12	1 / .25 10 / .35	40 24	1	Medium Speed Switching
2N427	— 15	0.4	0.18		0.4	0.44	0.25	0.3	11	12	1 / .25 10 / .35	55 30	1	High Speed Switching
2N428	— 12	0.4	0.18		0.1	0.33	0.25	0.3	17	12	1 / .25 10 / .35	80 40	1	High Speed Switching
TR-10	— 50	0.36	0.15	22						35			25 @ 50 V	Slow Speed Switching
TR-19	— 25	0.36	0.15	80					1.5	35			6	Slow Speed Switching
TR-87	— 25	0.36	0.15	38					0.5	35			6	Slow Speed Switching
TR-88	— 25	0.36	0.15	80					1.0	35			6	Slow Speed Switching
TR-269	— 25	0.4	0.18	40					4	20 max.			1	Medium Speed Switching
TR-760	— 15	0.4	0.18	40					5	14			1	Medium Speed Switching
TR-761	— 15	0.4	0.18	75					10	14			1	High Speed Switching
TR-762	— 6	0.4	0.18	100					20	14			1	High Speed Switching
TR-763	— 6	0.4	0.18	120					30	14			1	High Speed Switching
TR-764	— 20	0.4	0.18	200					25	14			1	High Speed Switching

The Industro Transistor Corporation is now delivering PNP Germanium Alloy-Junction transistors for computer, entertainment and industrial applications, meeting transistor requirements for prototype and production orders. More than 200 transistor types can be supplied in addition to those listed on these pages.

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- **QUALITY CONTROL** — all transistors are subjected to 100% testing and inspection.
- **RAPID SERVICE**—rush delivery schedule? Need a quick quotation? Call now at EXeter 2-8000.

(Note: NPN Germanium Alloy-Junction transistors will be available in late 1958.)

Cable Address: TRANDUSTRO

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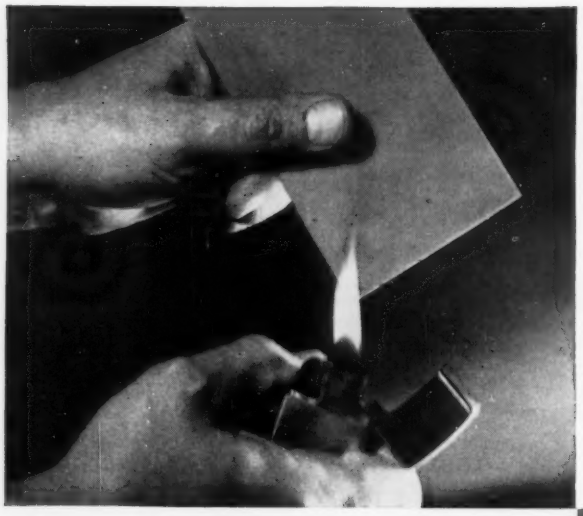
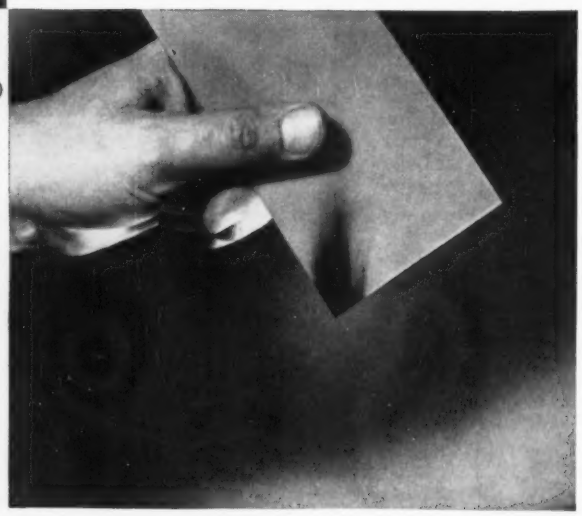


new

flame retardant plastic laminate

INSUROK® XT-901

by Richardson



Here's another new Richardson product which offers many advantages for electronic and electrical applications.

New INSUROK XT-901, as shown in the photos above, is flame retardant. This self-extinguishing feature is not affected by age or service conditions. This material also resists the formation of a carbonized path in the presence of an arc, which feature is desirable in many high voltage applications. Electrical characteristics of this paper base laminate, which is identified by its distinctive red color, exceed the published NEMA values for XXXP phenolic laminates. Electrical and arc resistance properties are retained after exposure to high humidity or immersion in water. It is readily fabricated and punches in the temperature range of 225-275°F.

USES FOR XT-901 INCLUDE:

- High voltage applications such as the TV flyback transformer.
- Applications involving sliding contacts because XT-901 has superior wear and abrasion resistance coupled with excellent arc resistance.
- Riveted assemblies such as relays because low cold flow assures retention of spacing.

Additional features are low water absorption and good dimensional stability under humid conditions.

Write today to Dept. 33 for more information on new XT-901.

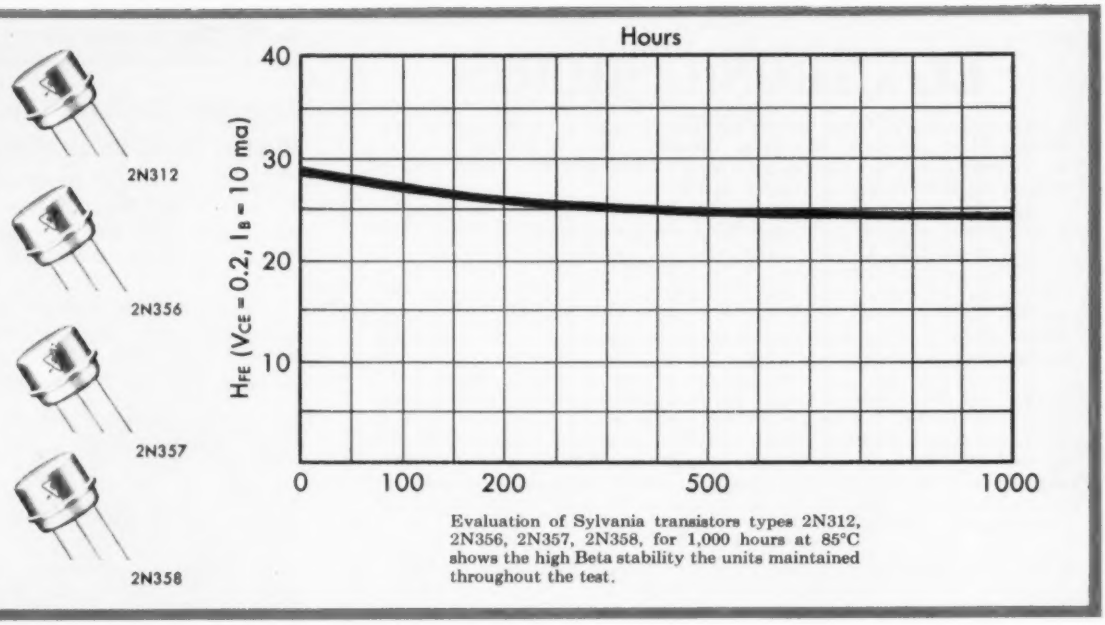
See XT-901 in Booth 1628—I.R.E. Convention
New York Coliseum—March 24-27, 1958

100 YEARS OF EXPERIENCE AND IMAGINATION 1858 1958

the RICHARDSON COMPANY

RICHARDSON PLASTICS LAMINATED and MOLDED

2790 LAKE STREET • MELROSE PARK, ILLINOIS • OFFICES IN PRINCIPAL CITIES



Evaluation of Sylvania transistors types 2N312, 2N356, 2N357, 2N358, for 1,000 hours at 85°C shows the high Beta stability the units maintained throughout the test.

Four more **Computer Transistors**

-from Sylvania

Sylvania widens its product line of high stability types designed especially for computer applications

Design engineers are now provided with an expanded line of computer transistors from Sylvania, basic source for high Beta units. The new additions, types 2N312, 2N356, 2N357 and 2N358, are NPN germanium alloy junction transistors. They exhibit the stable Beta characteristics and fast switching times that have made Sylvania types 2N377, 2N385 and 2N388 so popular. The new transistors are "base-off-the-can" types designed specifically for those applications where all transistor elements must be insulated from the metal case.

As with Sylvania original computer transistors, the types 2N312, 2N356, 2N357 and 2N358 meet EIA size group 30 dimensions. They also meet environmental tests typical of those required in military applications. Tests include temperature cycle, moisture resistance, centrifuge, and lead fatigue.

In addition to stable Betas at changing current levels, the four types have good leakage stability. Total dissipation for each unit is conservatively rated at 100 mw with ambient temperature at 25° C.

Typical Characteristics (25° C):	2N312	2N356	2N357	2N358
Collector Cutoff Current, I_{CBO}				
V_{CB} = 20, emitter open	—	20	20	20 ua
V_{CB} = 15, emitter open	10 ua	—	—	—
V_{CB} = 5, emitter open	—	3	3	3 ua
V_{CB} = 1, emitter open	2 ua	—	—	—
Emitter Cutoff Current, I_{EBO}				
V_{EB} = 20, collector open	—	20	20	20 ua
V_{EB} = 15, collector open	10 ua	—	—	—
V_{EB} = 5, collector open	—	3	3	3 ua
V_{EB} = 1, collector open	2 ua	—	—	—
Emitter Punch Thru, I_E				
V_{EB} = 0	—	20 (V_{CB} = 20)	20 (V_{CB} = 18)	20 ua (V_{CB} = 15)
Collector Punch Thru, I_C				
I_B = −25 ua (reverse bias)	—	500 (V_{CE} = 20)	500 (V_{CE} = 18)	500 ua (V_{CE} = 15)
R_{BE} = 10K	400 ua (V_{CE} = 15)	—	—	—
Current Gain, h_{FE}				
V_{CE} = 0.25, I_C = 100 ma	—	30	—	—
V_{CE} = 0.25, I_C = 200 ma	—	—	30	—
V_{CE} = 0.25, I_C = 300 ma	—	—	—	30
V_{CE} = 1.0, I_C = 10 ma	45	—	—	—
Saturation Voltage, V_{CE} (max.)				
I_C = 100 ma, I_B = 10 ma	—	0.2	—	—
I_C = 200 ma, I_B = 20 ma	—	—	0.2	—
I_C = 300 ma, I_B = 30 ma	—	—	—	0.2
I_C = 10 ma, I_B = 1 ma	0.075	—	—	—
Input Voltage, V_{BE} (max.)				
V_{CE} = 0.25, I_C = 100 ma	—	0.8	—	—
V_{CE} = 0.25, I_C = 200 ma	—	—	0.8	—
V_{CE} = 0.25, I_C = 300 ma	—	—	—	0.8
Rise Time	1.0	1.0	.6	.4
Storage Time	1.5	0.3	.3	.5
Fall Time	0.8	1.0	.6	.6

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal.

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Circle 6 on Inquiry Card, page 97

ELECTRONIC SHORTS

▸ Ramo-Wooldridge Corp. and its affiliate, Thompson Products, Inc., have formed Thompson-Ramo-Wooldridge Products, Inc., to develop and market industrial process control equipment. The firm's first major product will be the RW-300 digital control computer.

▸ Simple and effective techniques for soldering aluminum and its alloys as well as galvanized metals have been developed by metallurgists at the Bell Telephone Labs. Joints in aluminum made by these techniques which employ an inexpensive and stable zinc base alloy as a preferred solder, and no flux or vigorous abrasion, are stronger than commercial aluminum itself. Because of their simplicity they are expected to find widespread applications in industry.

▸ The Civil Aeronautics authority has made an agreement with the Canadian Department of Transport under which the U. S. has leased at a dollar per year for fifteen years, a gigantic electronics computer. It will be used as a dynamic operations air traffic control simulator. The five and one-half million dollar computer originally designed as a military tactical trainer is being converted for use in the study of day-to-day air traffic control problems.

▸ The Talos Defense Unit goes "one step beyond push-button warfare," according to Dr. Elmer W. Engstrom, Senior Executive Vice President, RCA. The electronic control center goes into action by itself in response to warning signals from remote outposts.

▸ An air-phone public telephone is being tried in a Northwest Airlines Stratocruiser. It can be used to call any place in the world while the plane is within a 175-mile radius of two special ground stations. The stations are in Chicago and Detroit.

▸ A technique for accurately determining transistor characteristics in the grounded emitter configuration at 30 to 300 MC has been developed by Bell Telephone Labs. Four measurements and subsequent calculations are made which yield the four complex hybrid parameters, and from these the validity as well as the element values of any equivalent circuit may be determined.

▸ A 100 ft. high, solid "dish," radio telescope will be built next June at the University of Michigan. Reflector diameter will be 85 ft. It will be the second largest steerable radio telescope in the world. The complete facility, capable of focusing on only 3% of the sun's surface at a time, will cost about $300,000.

▸ Future university programs in Japan will undergo drastic changes. That country's government, reappraising its whole educational system in reaction to Soviet advances with earth satellites and missiles, is obviously leading public opinion in this direction and the newspapers are helping. This movement, like the corresponding drive in the United States, will require heavy tax expenditures.

▸ The aircraft industry, in response to a plea by the Pentagon last spring to reduce overtime, has done just that. Bureau of Labor Statistics figures show that while the average work week in the aircraft and parts industry was 42 hours or more from January through April, the figure from May through August was under 41 hours. The August figure was 40.8 hours.

▸ A radar display indicator has been developed for the presentation of signals at distances up to 4,000 miles by Du Mont Laboratories under a subcontract with Lincoln Laboratories.

▸ The first digital computer reported to be fast enough to evaluate the performance of a missile in full flight has been introduced by Packard-Bell Computer Corp. The new unit is known as the "TRICE"—"Transistorized Real Time Incremental Computer, Expandable."

▸ Five hundred officers trained in the field of science will be added to the ranks of the Navy and Marine Corps annually under a new educational program. Beginning with the school year 1958-59, 500 EM will be enrolled in civilian institutions of higher learning for 4-year courses leading to a BS and to commissions in the Navy.

As We Go To Press (cont.)

Printed Circuits Gp. Elects McGinley Pres.

W. J. McGinley, president of Methode Mfg. Co., Chicago has been elected president of the newly formed Institute of Printed Circuits.

The aims of the new group are to develop standards and other educational material to aid the user to purchase and use printed circuits more efficiently and more economically, and to provide an organization for manufacturers in the industry to work together toward common goals.

New officers: (l. to r.) A. R. Hughes, R. G. Zens, R. L. Swiggett, Karl Clayton and W. J. McGinley.

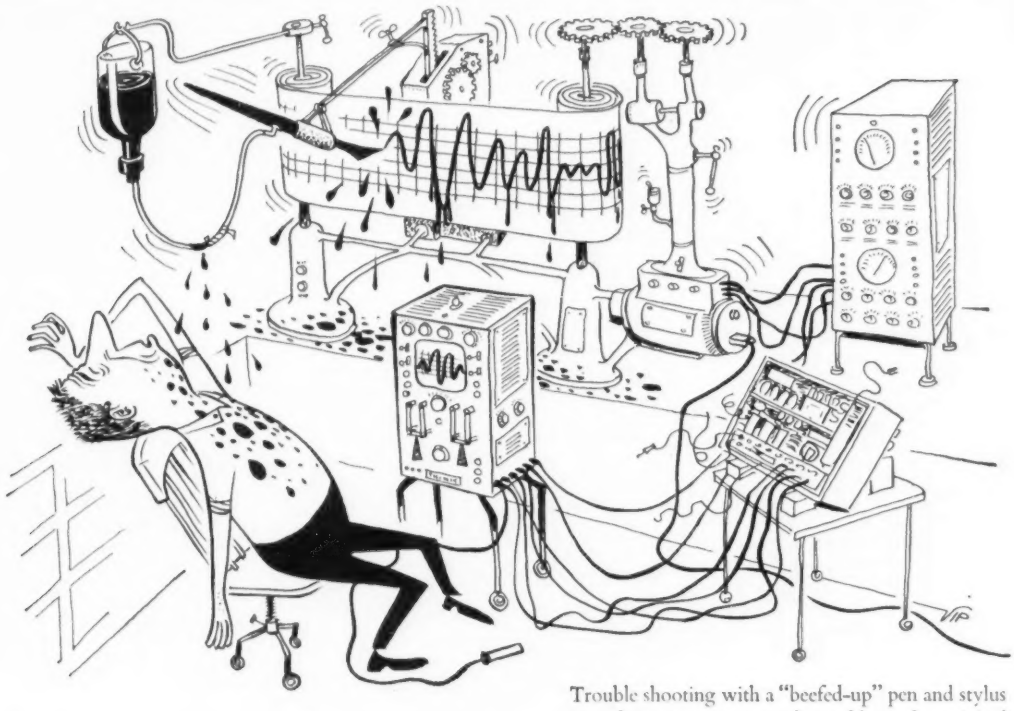
The other officers elected were: vice-pres., A. R. Hughes, Electralab Inc.; treasurer, R. L. Swiggett, Photocircuits Corp.; and directors, Karl Clayton, Tingstol Co., and R. G. Zens, Printed Electronics Corp.

WEATHER-BOUND

Special Aerobee rocket, loaded with high-explosive grenades, roars 60 mi. up to provide Army scientists with information on weather at high altitudes. First firings were held in Canada; more are planned for Guam.

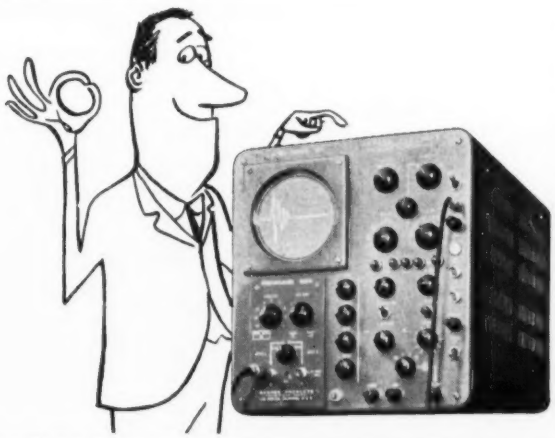
More News on Page 12

How to Save Man Days in Research and Testing Involving Transients—**No. 5** *of a series*



PROBLEM: Trouble Shooting

Trouble shooting with a "beefed-up" pen and stylus recorder can cause as much trouble as the original malady—thereby compounding the felony. Also, conventional recorders cannot capture high-frequency transients because of comparatively slow response.



SOLUTION: The Hughes **MEMO-SCOPE® Oscilloscope** can instantly "freeze" any number of selected traces. A storage type oscilloscope, it retains displays brilliantly *until intentionally erased*. Faithful reproduction of transients is assured always…for the electron beam has no appreciable weight, as opposed to the mass of mechanical recorder movement.

HUGHES MEMO-SCOPE OSCILLOSCOPE

STORAGE TUBE—5-inch diameter Memotron® Direct Display Cathode Ray Storage Tube. Writing speed for storage: 125,000 inches per second. The optional Speed Enhancement Feature multiplies writing speed approximately four times.

OPTIONAL PREAMPLIFIER EQUIPMENT—High Sensitivity, Differential Input, Type HS/6: 1 millivolt to 50 volts per division. Dual Trace Type WB/DI/11: 10 millivolts to 50 volts per division. Four independent positions may be selected for single or double channel performance and chopped or alternate sweeps.

We are sure you will want to see this "transient recorder with a memory" in action. A Hughes representative in your local area will arrange a demonstration in your company. Please write now to:

HUGHES PRODUCTS MEMO-SCOPE Oscilloscope
International Airport Station, Los Angeles 45, California

Creating a new world with ELECTRONICS

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Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period February to May that are of special interest to electronic engineers

Feb. 2-7: Winter Meeting, by AIEE; at New York City.

Feb. 3-4: Flight Control Symp.; at the Biltmore Hotel, Dayton, Ohio.

Feb. 4-6: Reinforced Plastics Conf., by SPI; Edgewater Beach Hotel, Chicago, Ill.

Feb. 7-8: Conf. by Administrative Application Div. of American Society for Quality Control; Carter Hotel, Cleveland, Ohio.

Feb. 10-12: Annual Marketing Conf. by American Management Ass'n; Statler Hotel, New York City.

Feb. 10-14: Committee Week, by American Soc. for Testing Materials; at Hotel Statler, St. Louis, Mo.

Feb. 13-15: Spring Meeting, Nat'l Society of Professional Engrs.; East Lansing, Mich.

Feb. 14-15: Cleveland Electronics Conf., IRE, AIEE, ISA & Cleveland Physics Soc.; Masonic Auditorium, Cleveland, Ohio.

Feb. 14-16: High Fidelity Show, by Inst. of High Fidelity Mfrs.; San Francisco, Calif.

Feb. 16-22: Engineering Exposition; at Balboa Park, San Diego, Calif.

Feb. 20-21: Conf. on Transistor & Solid State Circuits, by IRE; at Univ. of Pennsylvania, Philadelphia, Pa.

Feb. 20-21: 14th Annual National Wiring Promotion Conf.; Statler Hotel, Detroit, Mich.

Feb. 20-24: Industrial Relations Conf., by EIA; at Town & Country Hotel, San Diego, Calif.

Mar. 11-13: 8th Annual Conf. on Instrumentation for the Iron & Steel Industry; at Roosevelt Hotel, Pittsburgh, Pa.

Mar. 16-21: Nuclear Engineering & Science Conf., IRE, ASME, EJC & ANS; Chicago, Ill.

Mar. 24-27: IRE National Convention; at Waldorf-Astoria Hotel & Coliseum, New York, N. Y.

Mar. 25-28: Packaging Machinery & Materials Expos.; at Convention Hall, Atlantic City, N. J.

Mar. 26-28: American Power Conf., Illinois Inst. of Tech.; Hotel Sherman, Chicago, Ill.

Mar. 27-29: Electrical Industry Show; Shrine Exposition Hall, Los Angeles, Cal.

Apr. 2-4: Conf. on Automatic Optimization, AIEE, IRE, ISA, AIChE & ASME; Univ. of Delaware, Newark, Del.

Apr. 8-10: Symp. on Electronic Waveguides, IRE & Polytechnic Inst.; Engineering Societies Bldg., New York City.

Apr. 10-12: Regional Conf. & Electronics Show, by IRE; at Municipal Audit., San Antonio, Tex.

Apr. 14-16: Conf. on Automatic Techniques, by IRE, ASME & AIEE; at Statler Hotel, Detroit, Mich.

Apr. 14-17: 15th Annual Radio Component Show; Grosvenor House & Park Lane House, London, W. 1, England.

Apr. 16-25: Instruments, Electronics & Automation Exhibition; at Olympia Hall, London, England.

Apr. 22-24: Electronic Components Conference, IRE, WCEMA, AIEE, & EIA; at Ambassador Hotel, Los Angeles, Calif.

Apr. 23: Annual Meeting, PACE; Governor Clinton Hotel, New York City.

Apr. 30-May 2: Tech. Conf. & Trade Show, IRE; Sacramento, Calif.

May 4-7: 4th National Flight Test Instrumentation Symp., IAS; Park Sheraton Hotel, New York City.

May 5-7: National Symp. on Microwave Theory & Techniques, IRE; at Stanford Univ., Stanford, Calif.

May 6-8: 1958 Western Joint Computer Conf., IRE, ACM & AIEE; at Ambassador Hotel, Los Angeles, Cal.

May 7-17: 2nd U. S. World Trade Fair; at New York, N. Y.

May 12-14: National Aero & Navigational Electronic Conf., IRE; at Dayton, O.

May 19-21: 1958 Electronic Parts Distributors Show; Conrad Hilton Hotel, Chicago 3, Ill.

Abbreviations:

ACM: Association for Computing Machinery
AIChe: American Institute of Chemical Engineers
AIEE: American Inst. of Electrical Engrs.
ANS: American Nuclear Society
ASME: American Society of Mechanical Engineers
EJC: Engineers Joint Council
EIA: Electronic Industries Assoc.
IAS: Inst. of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
PACE: Producers of Associated Components for Electronics
WCEMA: West Coast Electronic Manufacturers Association

As We Go To Press (cont.)

NEW ARMY DRONE

New SD-3 surveillance drone, being produced for the Signal Corps by Republic, uses advanced sensory devices. Interchangeable nose units permit rapid switching from one device method to another. Drone is JATO-launched.

U. S. Arsenal Includes 10 Operational Missiles

At the end of 1957 the U. S. had a total of 10 operational guided missiles, according to the Dept. of Defense. The Navy was the leader with 5 missiles, the Air Force next with 3 missiles, and the Army had 2.

Navy

Sidewinder ..... air-to-air
Petrel .....air-to-surface
Regulus ..... surface-to-surface
Terrier ..... surface-to-air
Sparrow I .....air-to-air

Air Force

Matador .....surface-to-surface
Falcon .....air-to-air
Genie ..... air-to-air

Army

Nike-Ajax .....surface-to-air
Corporal .....surface-to-surface

FCC Authorizations Total 1,900,000

The close of 1957 found the Federal Communications Comm. with about 1,900,000 radio authorizations on its books. This is the largest number in its 23 years of existence.

It is significant that for every broadcast facility there are nearly 50 radio stations of other kinds which serve the public, commerce and individuals. Altogether, about 1,250,000 fixed and mobile transmitters are in use.

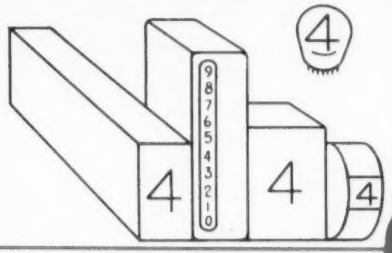
Operation of these transmitters accounts for nearly 1,500,000 operator permits of different grades —more than 1,300,000 commercial and over 160,000 amateur.

only NIXIE® indicating tubes

HAVE THESE EXCLUSIVE FEATURES

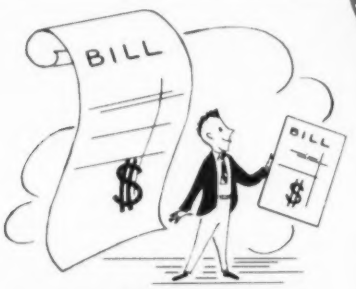
MOST READABLE DEVICE

SMALLEST VOLUME FOR NUMBER SIZE



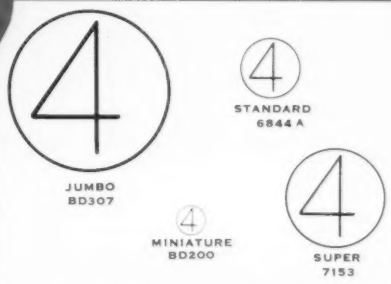
LIGHTEST WEIGHT

MAXIMUM TEMPERATURE SHOCK AND VIBRATION SPECS



LOWEST COST

LOWEST POWER



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SOME TYPICAL NIXIE® APPLICATIONS

- INDUSTRIAL CONTROL
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- COUNTERS
- COMPUTERS
- MILITARY ELECTRONIC INDICATORS
- CHANNEL INDICATORS
- INDICATOR BOARDS
- DIGITAL VOLTMETERS
- PAGING SYSTEMS
- ELEVATORS
- RADAR

Compare these all-electronic readout tubes with anything on the market today . . . for price, for performance, for reliability. You'll find that the Burroughs Nixie® is the most "perfect" indicating tube ever mass-produced.

These gas-filled, cold cathode tubes contain ten digits or letters. Any individual number or letter can be easily selected and displayed in a common viewing area.

Other Nixie® advantages are: Long life — Unlimited rate of change — Multiple remote indications from one driving circuit — Production uniformity from tube to tube and number to number — Perfectly formed numbers, precisely aligned — rugged construction — Simple plug-in stem, hidden tubulations — Human engineered for Performance, Appearance and Reliability.

Write for information on these and other tube styles

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ANOTHER ELECTRONIC CONTRIBUTION BY

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

Circle 8 on Inquiry Card, page 97

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Assay (HF)	49.00±0.25%

Maximum Limits of Impurities

Fluosilicic Acid (H_2SiF_6)	0.05 %
Residue after Ignition	0.001 %
Chloride (Cl)	0.0005 %
Phosphate (PO_4)	0.0003 %
Sulfate (SO_4)	0.0005 %
Sulfite (SO_3)	0.001 %
Arsenic (As)	0.000005%
Copper (Cu)	0.00005 %
Heavy Metals (as Pb)	0.0001 %
Iron (Fe)	0.0001 %
Nickel (Ni)	0.00005 %

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...with metallic and other impurities held to lower limits than ever before!

Typical of B&A's special line of extremely pure "Electronic Grade" chemicals is its Hydrofluoric Acid. Note the specifications above . . . the carefully controlled assay, within plus or minus 0.25% . . . and the remarkably low limits on metallic and other undesirable impurities.

With products such as this, Baker & Adamson serves the needs of the electronic industry for chemicals of a new order of purity. And as the country's leading producer of laboratory and scientific chemicals, it is geared to work closely with the industry's engineers and chemists in developing other products to meet their most stringent requirements.

Now available are the following B&A "Electronic Grade" chemicals:

For semiconductors (small packages):

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Acid Hydrofluoric, 48%
Alcohol Methyl, Absolute (Methanol) Acetone Free
Alcohol Propyl, Iso
Carbon Tetrachloride
Ether, Anhydrous
Hydrogen Peroxide, 3%
Hydrogen Peroxide, 30%
Hydrogen Peroxide, 30% "Stabilized"
Sodium Carbonate, Monohydrate
Trichloroethylene

For radio receiving, black and white TV tubes (available in bulk):

Aluminum Nitrate, Crystal and Basic
Barium Acetate
Barium Nitrate
Calcium Nitrate, Tetrahydrate
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Other special purity chemicals can be custom-made to meet your needs.

Write for free folder! Contains information on electronic chemicals for semiconductors, tubes, printed circuits; sulfur hexafluoride for gaseous insulation; selenium metals and selenides; metallic compounds for ferrite production. Lists exact specifications for "Electronic Grade" small package chemicals. Write for your copy today!

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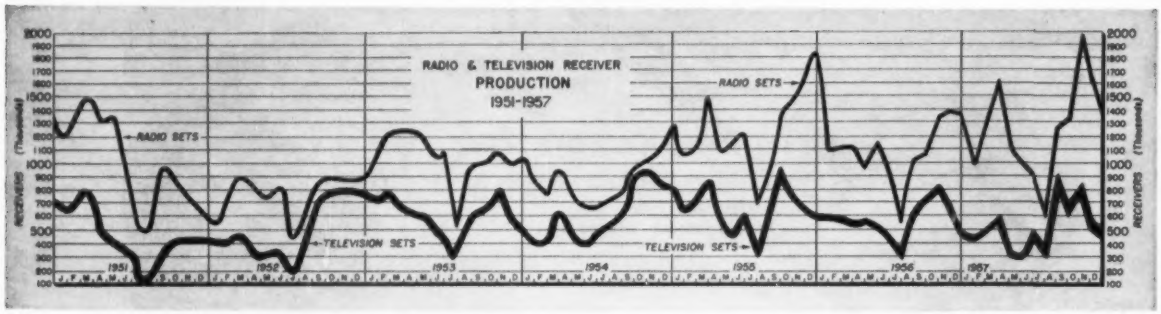
TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in December 1957.

Amplifiers	33,850
Analyzers, Pulse	1,172,316
Batteries, Dry	281,274
Batteries, Storage	2,042,664
Beacon Sets, Radio	75,799
Cable Assemblies	108,480
Cable Sets, Interconnecting	111,280
Capacitors	34,969
Computers & Accessories	275,514
Connectors	26,026
Crystal Units	27,583
Fire Control Equipment	1,000,000
Generators, Signal	29,853
Headsets	97,604
Indicators	447,542
Kits, Modification	104,600
Meters	26,249
Meters, Frequency	90,495
Microwave Equipment	306,602
Radar Repair Parts	50,000
Radiac Equipment	178,560
Radio Equipment	120,930
Radio Receivers—Transmitters	44,640
Radio Transmitters	824,355
Radiosonde Equipment	158,806
Rectifiers, Semiconductor	112,556
Relays	90,228
Resistors	63,370
Switches	189,016
Synchros	124,414
Tape, Recording	66,928
Teletype Equipment	26,835
Test Equipment, Various	4,629,361
Testers	53,040
Test Sets	61,146
Test Sets, Electrical	944,949
Test Sets, Radar	810,157
Transformers	39,990
Transistors	52,484
Tubes, Electron	2,739,537
Wire & Cable	156,721

PROGRAMMED OBLIGATION TOTALS FOR U. S. MISSILES PROGRAMS

(Footnote 1 below indicates the scope of the figures shown.)

(Millions of dollars)

Fiscal Year	Total Missile Program	Surface-to-Surface Missile Program[3]	Long Range Surface-to-Surface Missile Program[3]	IRBM and ICBM Missile Program[3]
1946 & prior	70	19	9	[4]
1947	58	20	6	
1948	81	36	11	
1949	98	45	18	
1950	134	65	22	
1951	784	186	113	
1952	1058	240	143	
1953	1166	406	270	3
1954	1067	350	258	14
1955	1470	559	376	161
1956	2270	902	679	515
1957	4284	2000	1743	1380[2]
1958 (prelim.)	4638	2100	1928	1400

NOTE 1. Program data contained in this table include the cost of bringing guided missile weapon systems to an operational status, combining research and development, production facility expansion and tooling, procurement, contract and military overhead to support missile testing and certain construction costs for research and development. The figures above do not include military pay, the cost of maintaining and running operational sites, constructing installations not included in research and development costs, or building or converting ships incident to the guided missile program.

NOTE 2. Unusually high expenditures in FY 1957 were due to large non-recurring capital investment in test facilities.

NOTE 3. Each of the above columns is a part only of the preceding column to the left.

NOTE 4. Totals less than one million dollars are not included above.

FCC NOTES

Safety and Special Services

Authorizations in the Safety and Special Radio Services now exceed 400,000. They represent the use of some 1,200,000 transmitters. Of these:

Nearly 70,000 land and ship stations aid water navigation and transportation.

About 62,700 U. S. ships are radio-equipped. Of this number some 1,400 use radiotelegraph. In addition, 3,500 ships have radar.

Almost 60,000 ground and air stations facilitate aviation operations. Some 40,300 aircraft are radio-equipped.

About 42,000 authorizations covering over 307,000 transmitters assist land transportation. Included are 105,500 transmitters used by taxicabs, 51,300 by railroads, 33,300 by trucks, and nearly 4,000 by buses.

Nearly 40,000 authorizations with over 325,000 transmitters are concerned with industry. Power employs 125,000 transmitters, petroleum 43,400, forest products 14,000, and miscellaneous industry nearly 144,000.

Almost 25,000 authorizations involving nearly 245,000 transmitters are dedicated to public safety functions. Police transmitters number nearly 150,000, fire transmitters nearly 50,000, forestry conservation nearly 30,000, and highway maintenance and emergency nearly 20,000.

Broadcast Services

Broadcast authorizations collectively now approximate 8,500. They include:

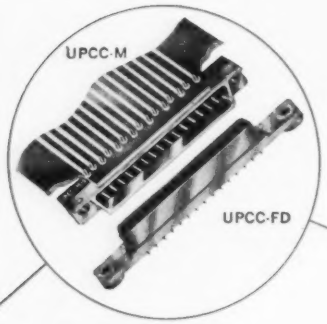
About 3,300 AM stations.

More than 800 TV stations. Of these, over 650 are commercial, over 100 are translators, and over 50 are educational.

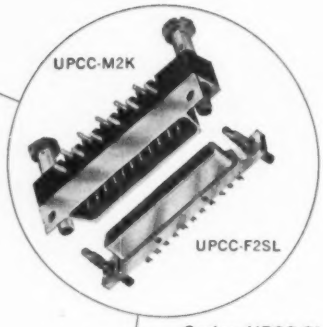
More than 700 FM stations. Nearly 600 of these are commercial and over 150 are educational.

Two stations which send programs overseas.

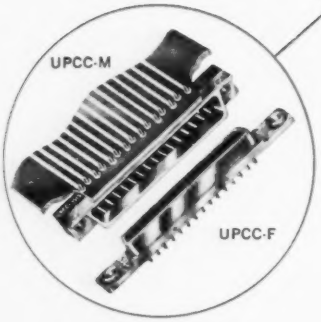
Auxiliary, remote pickup, studio-transmitter links and other adjuncts account for the remaining 3,600 broadcast authorizations.



Series UPCC-FD
Female chassis connector-dip solder terminals.

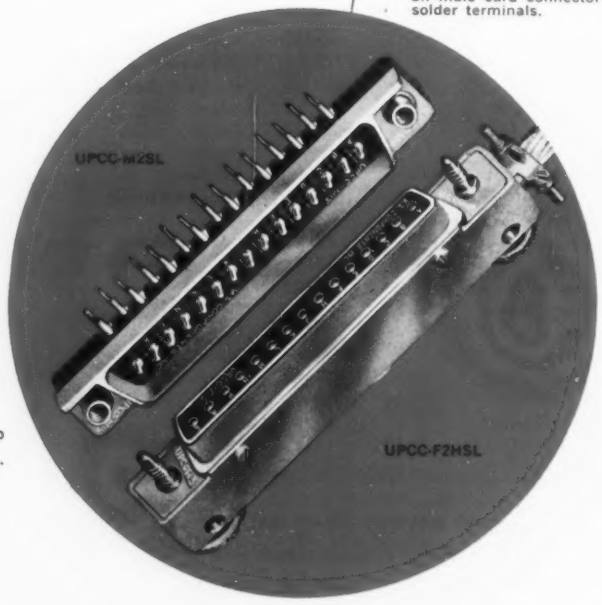


Series UPCC-SLK*
(Knob Screw-Lock).
Female chassis connector-wire solder terminals. Knob on male card connector-dip solder terminals.



Series UPCC-M & -F
NAS standard.
Male card connector-dip solder terminals.
Female chassis unit with wire-solder terminals.

and now...



Series UPCC-SLH*
Male chassis connector-dip solder terminals.
Female hooded connector-wire solder terminals.

another "demand" member has joined U.S.C.

family of Printed Card Connectors . . . the new, hooded screw lock Series UPCC . . . SLH bringing the total of different available types to over 150.

- Conforms to MIL-C-8384 and NAS specs.
- Molding materials—melamine and diallyl phthalate
- Die cast aluminum shells—aluminum hoods
- Ideal for critical environmental conditions
- Silver plated—gold flash contacts
- Screw lock elements—stainless steel—double lead for double speed

All UPCC-M & -F units available with wire-solder; turret type; or solder dip terminals (for 1/16, 1/8, 1/4" boards).

Max. Wire Size	#18 AWG
Voltage Breakdown (Min.)	1800v, AC, RMS
Insulation Resistance	over 5000 megohms
No. of contacts	7, 11, 15, 19, 23
Current Ratings	7.5 amps

Also custom configurations to meet your specific application requirements.

*Pat. Pend.

U.S. COMPONENTS, INC. associated with U. S. Tool & Mfg. Co., Inc.
454 East 148th Street • New York 55, N. Y. • CYpress 2-6525

Why SHOULDN'T I be interested in business life insurance?

"Our future depends on the future of my husband's business."

Every businessman — owner, partner, stockholder — has a vital stake in the future of his business . . . and his family may face real hardship *unless* he has prevented possible financial disaster through sound business planning.

One of the greatest hazards can be death of an owner of the business. Ætna Life's Business Planning Service can be instrumental in protecting your family's future security when this happens.

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ÆTNA BUSINESS LIFE INSURANCE PLANS ARE SPECIALLY DESIGNED . . .

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- To preserve **SOLE PROPRIETORSHIPS** for heirs or selected employees.
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- To indemnify any firm for the death of a **KEY MAN.**

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Ætna Life Insurance Company
Hartford 15, Connecticut

Gentlemen:

Please send me a copy of your new business life insurance booklet "Will This Man Take Your Business With Him When He Dies?"

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Address_____

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Electronic Industries' News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

FRIEZ INSTRUMENT, div. of Bendix Aviation Corp., is now manufacturing, selling, and servicing on Magnesyn aircraft instruments.

HARRIS-INTERTYPE CORP., manufacturers of equipment and supplies for the printing and publishing industry, purchased Gates Radio Co.

INTERNATIONAL RESISTANCE CO. has added two new printed circuit laminates to its line: Fluoroply-P, -E. The former has a punchable XXXP phenolic base; the latter, an epoxy fibre glass board as the base.

STROMBERG-CARLSON has been awarded a Navy contract for $3.7-million for the production of test equipment in connection with TACAN.

WESTINGHOUSE ELECTRIC CO. has established a microwave tube center at Ithaca, N. Y. The center will be located at 310 N. Aurora St., and will be headed by E. C. Okress.

GENERAL CERAMICS CORP. has expanded the facilities of its Memory Card Products Dept. and increased its technical staff to design and manufacture complete magnetic core memory systems for custom applications.

MARCONI INSTRUMENTS have moved from New York City to larger quarters at 111 Cedar Lane, Englewood, N. J. Phone: LOwell 7-0607.

CURTISS-WRIGHT CORP., INDUSTRIAL & SCIENTIFIC PRODUCTS DIV., has opened a new plant, located on New Jersey Route 533, Quaker Bridge Rd., one-half mile east of Route 1, Princeton, N. J. It will be used for the development of their ultrasonic cleaning and testing product lines.

TEXAS INSTRUMENTS INC. has appointed Genesee Radio and Parts Co., Inc., 2550 Delaware Ave., Buffalo 16, N. Y., as a new semiconductor distributor.

AMP INCORPORATED has changed the name of its Chemical & Dielectric Div. to Capitron Div. It is located at 155 Park St., Elizabethtown, Pa.

AVCO MANUFACTURING CORP. has established a marketing department at its Research and Advanced Development Div. Robert D. Davis will administer the post.

EISLER TRANSFORMER CO., INC., is the name of the wholly owned subsidiary of Eisler Engineering Co. The transformer subsidiary has just occupied a newly constructed plant at 16 N. Salem St., Dover, N. J.

PHELPS DODGE COPPER PROD. CORP. installed the 230,000-volt low pressure, oil-filled cables serving the largest generator unit of the Niagara Mohawk-Power Corp., which was recently put into continuous operation at the C. R. Huntley Station near Buffalo, N. Y.

DATA-CONTROL SYSTEMS INC. has been formed to develop, manufacture, and sell equipments in the instrumentation field. Dr. Robert J. Jeffries, ISA President, will serve as the company's first President. The office is located at 39 Rose St., Danbury, Conn.

GRUMMAN AIRCRAFT ENGINEERING CORP. has been awarded an $86-million production contract for the F9F-8T Cougar fighter trainer and the WF-2 Tracer early warning aircraft.

INDUCTION MOTORS CORP. is adding a hysterises line of motors to its existing production of custom design motors. Expanded application and growth of the tape recorder business are responsible.

LOCKHEED'S GEORGIA DIV. is entering a nuclear field by designing and building atomic reactors to be used as a source of power and heat.

PHILCO TECHREP DIV. has made available the training facilities of its technological center to help meet the manpower shortage. Formerly these training facilities were available only to Philco personnel.

MID-WEST

SYNTHANE CORP. has relocated its Cleveland sales office to 3597 Lee Rd., Cleveland 20. Foster A. Hall is the District Sales Rep.

AMPEREX ELECTRONIC CORP. has opened a Chicago regional office. Roger Gabbei will cover all the firm's business in the Chicago area, Northwest Indiana, and Northeast Illinois.

P. R. MALLORY & CO., INC., has had the executive departments of its Indianapolis offices redesigned by Peter Schladermundt Assoc., New York industrial-design firm.

FORMICA CORP. has created a new North Central regional office which will be located in the American Cyanamid consolidated offices at 3505 N. Kimball Ave., Chicago, Ill.

SHURE BROS., INC., has placed on the market a new version of the Studio Dynetic photograph tone arm and cartridge designed for installations where space is limited. Model number is M12.

FOREIGN

BECKMAN INSTRUMENTS, LTD., a subsidiary of the California firm, reports that construction is well underway on its new $250,000 manufacturing plant at Glenrothes, Scotland.

PHILCO CORP. S. A., of Fribourg, Switzerland, has concluded agreements with James N. Kirby Mfg. Pty. Ltd., of Camperdown, N.S.W., Australia, for the manufacture and distribution of the full range of Philco appliances.

GEO. STEVENS MFG. CO., INC., has expanded its coil winding machine sales program to include Puerto Rico, Cuba and all other Caribbean lands. Personal contact will be maintained by Benz Sales Co., 3369 Southwest 4th St., Miami 24, Fla.

ELECTRICAL PRODUCTS MFG. CO., LTD., Mt. Royal, Quebec, has received an exclusive license to manufacture and sell Du Mont TV receivers, phonographs, and radios in the Dominion of Canada. The firm occupies a recently completed, mechanized 100,000 sq. ft. plant at 5785 Pare St., Mt. Royal.

MINNEAPOLIS-HONEYWELL REGULATOR CO. supplied the instrumentation for France's huge plutonium extraction plant which is scheduled to be placed in full operation this year.

WEST

LOCKHEED MISSILE SYSTEMS DIV. has more than 50 scientists, engineers, and electronic experts exploring the problems of sending and receiving radio and radar signals across the vast reaches of outer space.

ELECTRONIC ENGINEERING CO. OF CALIF. has moved to 1601 E. Chestnut Ave., Santa Ana, Calif.

MYCALEX CORP. OF AMERICA, PACIFIC DIV., is now located at 2810½ Glendale Blvd., Los Angeles 39, Calif.

FEDERAL TELECOMMUNICATION LABS. has occupied its new one-story, fully air-conditioned laboratories in San Fernando, Calif. The building offers 22,400 sq. ft. of floor space.

NON-LINEAR SYSTEMS, INC., has released for production a completely new line of Transistorized Digital Multimeters.

CONVAIR-ASTRONAUTICS has installed a huge centrifuge that can exert a force equal to 100 times the pull of gravity on test components of the Atlas intercontinental ballistic missile.

GENERAL ELECTRIC'S wire and cable manufacturing facilities will be expanded at Oakland, Calif., by taking over the space now being occupied by the Industrial Control Dept.

COHU ELECTRONICS, INC., has created a new research division which will be headed by Dr. Martin L. Klein. Laboratories for the new division will be at 14743 Lull St., Van Nuys, Calif.

MAGNETIC RESEARCH CORP. has formed the Stablvolt Div. The new division is located at 200 Center St., El Segundo, Calif.

MOTOROLA, INC., introduced a new subcarrier system for "Selcal" signal transmission at the Airlines Electronics Engineering Committee (Aeronautical Radio, Inc.), meeting in San Francisco.

BECKMAN INSTRUMENTS, INC., SYSTEMS DIV., has announced a digital pressure recording system. The Model 5770 is designed for applications such as production testing of pressure switches.

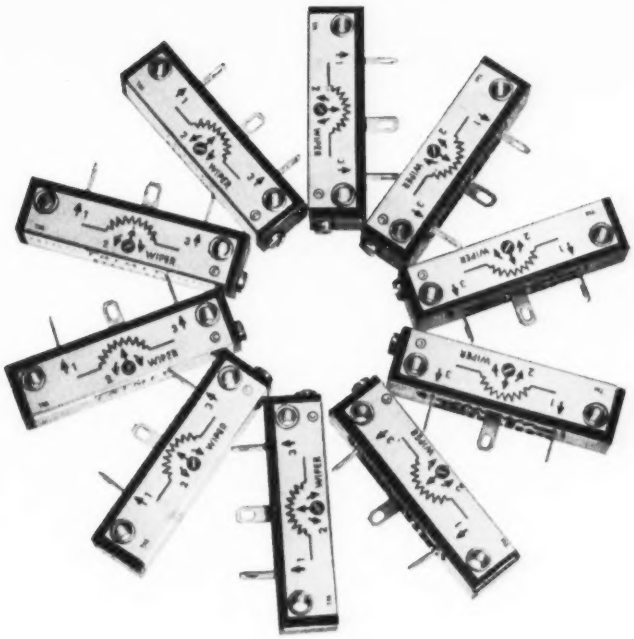
COLLINS RADIO CO. has received a $300,500 order for microwave and wire line carrier systems for the Delta County Cooperative Telephone Co. in Colorado.

ELECTRO PRECISION CORP. is the name of a new Arkansas company specializing in industrial control systems. John Hosemann will serve as first President of the firm which is located in Arkadelphia. Mr. Hosemann was formerly with the GE Aircraft Gas Turbine Div.

PACKARD-BELL ELECTRONICS CORP. has acquired full rights to Aerotape, a new miniature, modular, airborne, magnetic tape recorder-reproducer.

HELIPOT DIV., BECKMAN INSTRUMENTS, INC., received a certificate of merit, marking completion of 550,000 man hours without a lost-time accident in the Newport Beach and Costa Mesa plants.

AMPEX CORP., developed a tape recording machine for General Electric Co. which will be used in the Atlas ICBM.



HERE'S TRIMIT® ... A NEW TYPE OF ADJUSTMENT POTENTIOMETER FOR COMPUTERS, CONTROLS, COMMUNICATIONS, TEST EQUIPMENT

Compared with the average control-type single-turn rotary potentiometer, TRIMIT adjustment *accuracy* is a 33:1 improvement. TRIMIT provides 9000° of rotation instead of 270°. Easier repeatability, too.

TRIMIT *geometry* is a 6:1 to 12:1 improvement—you can mount 12 units in a panel area of only 1 square inch. They fit flat against printed circuits, into tight corners, between components.

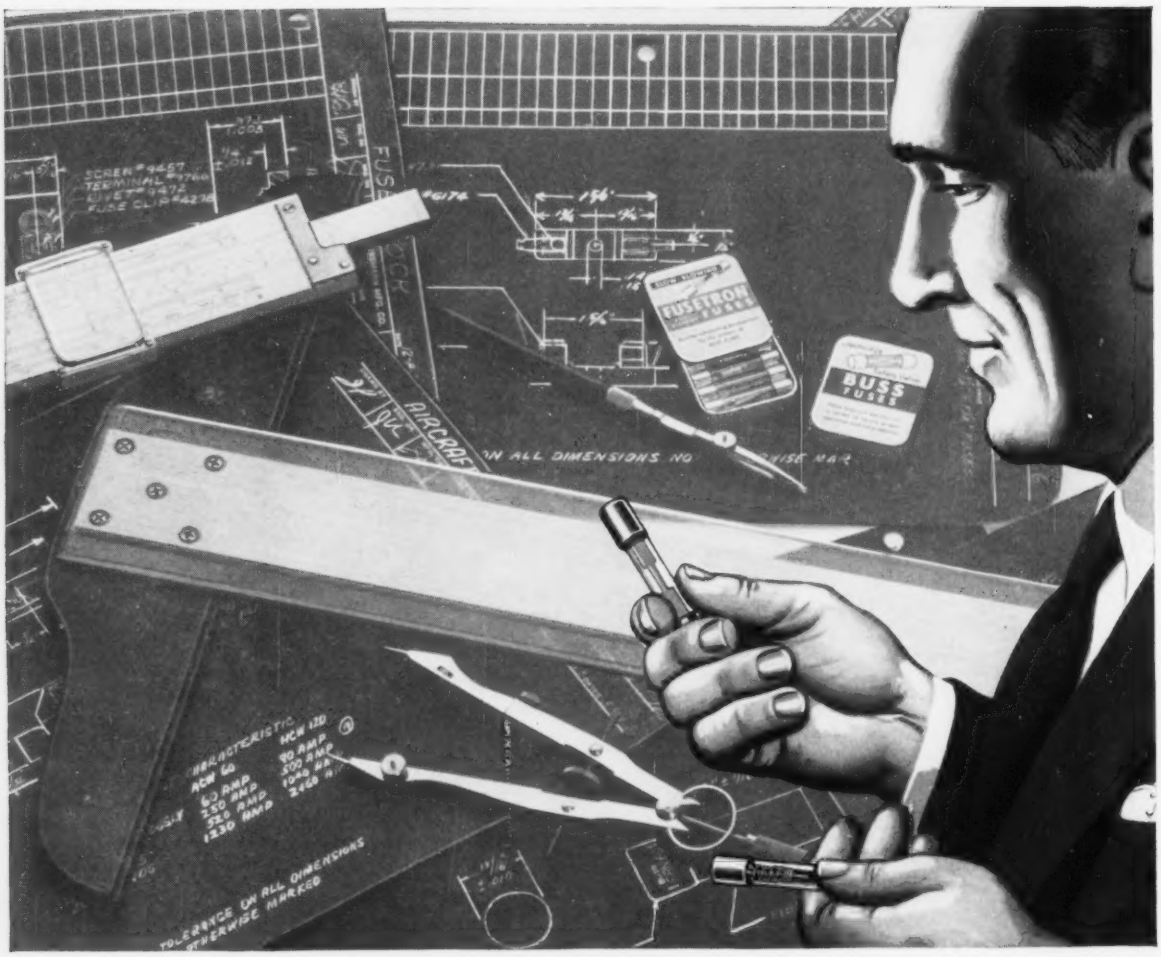
The screwdriver-adjusted TRIMIT settings are extremely *stable*. The screw-actuated mechanism is virtually immune to shock or vibration.

Write today for more information on TRIMIT.

BOURNS
Laboratories, Inc.

P.O. Box 2112 • Riverside, California

ORIGINATOR OF TRIMPOT® AND POTENTIOMETER INSTRUMENTS



For every fuse application — there's a safe and dependable BUSS fuse . .

You'll save time and trouble by specifying only BUSS fuses!

You can select a fuse that meets your exact circuit protection requirement from the complete BUSS fuse line. There are fuses in all sizes and types for the protection of television, radio, instruments, controls, avionics and other electronic and electrical equipment. A companion line of fuse clips, blocks and holders is most complete.

Relying on BUSS as your one source for fuses saves you time, trouble and simplifies record keeping.

Specifying BUSS fuses helps safeguard good name of your product

Faulty fuses can cause trouble by failing to protect — or by blowing needlessly. Users of your product would then be faced with unnecessary repair bills or needless shutdowns. Such an experience could jolt the users confidence in your product.

By specifying BUSS fuses, you are sure of dependable electrical protection under all service conditions. Every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Should you have a special problem in Electrical protection . . . The BUSS fuse engineers are at your service — and in many cases can save you engineering time by helping you choose the right fuse for the job. Whenever possible, the fuse selected will be available in local wholesalers' stocks so that your device can be serviced easily.

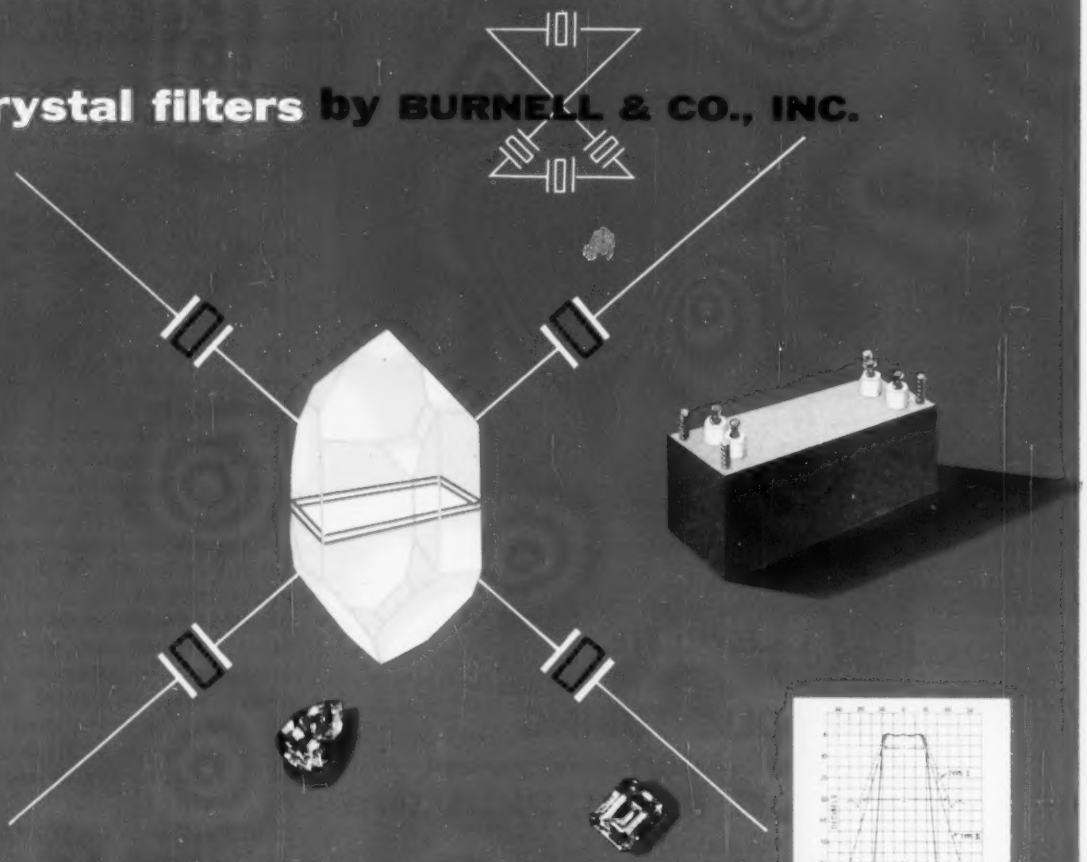
Before your final design is crystalized, be sure to get the latest information on BUSS and FUSETRON Small Dimension fuses and fuseholders . . . Write for bulletin SFB. Bussmann Mfg. Division McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.

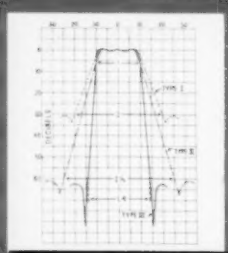
FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

MAKERS OF A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

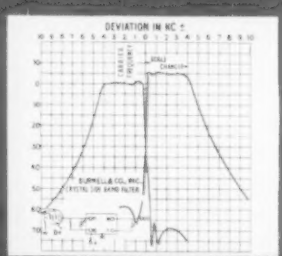
BUSS fuses are made to protect – not to blow, needlessly

crystal filters by BURNELL & CO., INC.

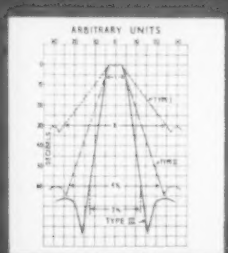




WIDE BAND CRYSTAL FILTER



SINGLE SIDE BAND CRYSTAL FILTER



NARROW BAND CRYSTAL FILTER

Like fine jewels, crystal filters are synonymous with stability, permanence and reliability. With the development of advanced production techniques and circuitry by Burnell & Co., they offer vast potential in electronic communications, telemetry, and remote control applications.

Depending on band width and frequency, they may be composed entirely of crystals, or in complex networks, combine quartz crystal elements with stabilized toroidal coils to produce the desired band width and shape factor. Frequency has been extended from low range to the megacycle spectrum so that Burnell Crystal Filters now provide the solution to myriad problems formerly insoluble with even the best of toroidal components.

Economical, standardized complex designs of lattice networks and their three terminal network derivatives preclude high developmental costs. Packaging encompasses a wide range in standard, miniature and sub-miniature sizes with considerable latitude in permissive impedance range from required transistor usage to pentode operation. Whether your crystal filter is of standard design or calls for custom specifications, our facilities are at your disposal. Write for new Burnell Crystal Filter Bulletin, XT-455.

Burnell & Co., Inc.

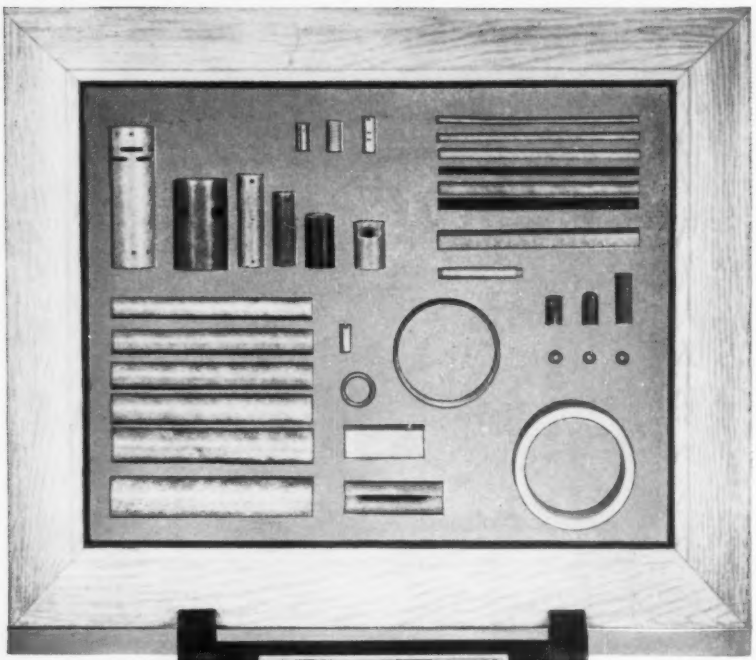
first in toroids, filters and related networks

Dept. I-2

EASTERN DIVISION
10 PELHAM PARKWAY
PELHAM MANOR, NEW YORK
PELHAM 8-5000

PACIFIC DIVISION
720 MISSION ST.
SOUTH PASADENA, CALIF.
RYAN 1-2841

Circle 14 on Inquiry Card, page 97



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PHENOLIC TUBING

has the Electrical and Physical Features you need

for COIL FORMS, COLLARS, BUSHINGS, SPACERS, CORES

CLEVELITE* HAS

HIGH HEAT RESISTANCE... over 250°F. continuous

GOOD DIELECTRIC STRENGTH, 150 v. p. m. wall

LOW MOISTURE ABSORPTION

NON-TRACKING and INSULATION RESISTANCE

CLEVELITE IS

UNAFFECTED BY OILS and SOLVENTS

MECHANICALLY and STRUCTURALLY STRONG

EASILY PUNCHED and MACHINED

AVAILABLE IN DIAMETERS ... from .090" to 8.000" ... and in WALL THICKNESSES ... from .0075" to .250" ...

You will be pleased at the low prices ... write for your copy of our lastest Clevelite brochure.

Visit our Exhibit #2319, Radio Engineering Show, Coliseum, New York City, March 24-27

*Reg. U. S. Pat. Off.

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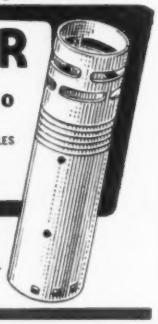
ABRASIVE DIVISION at CLEVELAND, OHIO

Cleveland Container Canada, Ltd., Prescott and Toronto, Ont.



Representatives:

NEW YORK AREA: R. T. MURRAY, 604 CENTRAL AVE., EAST ORANGE, N. J.
NEW ENGLAND: R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA: PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST: IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

Tele-Tips

INFRARED ENGINEERS say nylon is invisible to infrared detectors. Objections have been raised that public demonstrations of infrared techniques have "unclothed" some of the subjects. Engineers are seriously at work on filters to eliminate this difficulty.

ITV is becoming a familiar abbreviation, but it has two distinct meanings. In the U. S. it is Industrial Television, or closed-circuit; in England it means Independent Television, or non-BBC stations.

HIGH-PRESSURE TESTS are being conducted by Government scientists inside a flawless 7½ carat diamond that was confiscated from a smuggler. In a needle-sized hole drilled through the gem, they are testing materials at pressures as great as 450,000 lbs. to the square inch.

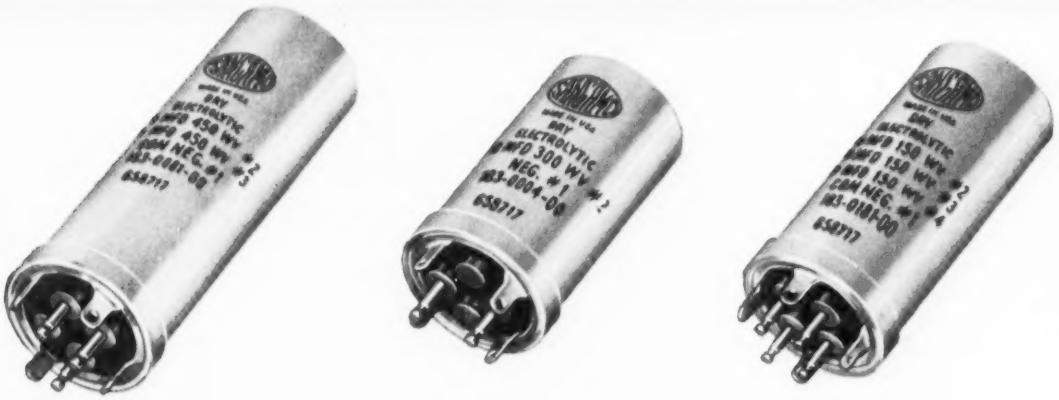
ELECTRONIC COMPUTER was diverted from its pursuit of mathematical solutions long enough to play the part of flutist in a Christmas musical recital. Bendix engineers recorded the score on the magnetic drum of one of their G-15 computers and installed a sound amplifier to pick up the harmonized electronic tones.

TOP MANAGEMENT of U. S. and Canadian companies got an average 5.1% raise last year, compared with a 5.9% increase in 1956.

MISSILE ENGINEERS at G.E. found a new use for the old bromide—Bromo-Seltzer. The problem was to delay the operation of electronic markers used to locate instrument housings ejected from missiles just before crashing. The engineers found that Bromo-Seltzer, packed around electrical wires, delays completion of the electronic circuit for the few minutes desired.

(*Continued on page* 28)

NEW HIGH RELIABILITY



IN ELECTROLYTIC CAPACITORS!

These new dry electrolytic capacitors are especially built for applications that require an extremely high level of reliability over long periods of time.

Sangamo Type TR capacitors are designed to operate in a temperature range from —20°C to +85°C.

The Type TR is well suited for use in communication systems; in all types of electronic industrial controls, laboratory test instruments, computer equipments, and in many other similar applications. Type TR capacitors are available in ratings from 3 to 450 volts D.C.

Sangamo Type TR

TWIST-TAB ELECTROLYTICS

have a life expectancy of at least 10 years when operated within their ratings These high reliability dry electrolytics are designed with safety factors to pass high ripple currents.

The use of high purity aluminum foil assures lower leakage current, and a highly effective end seal gives these capacitors unusually long operating life provided they are operated within their ratings.

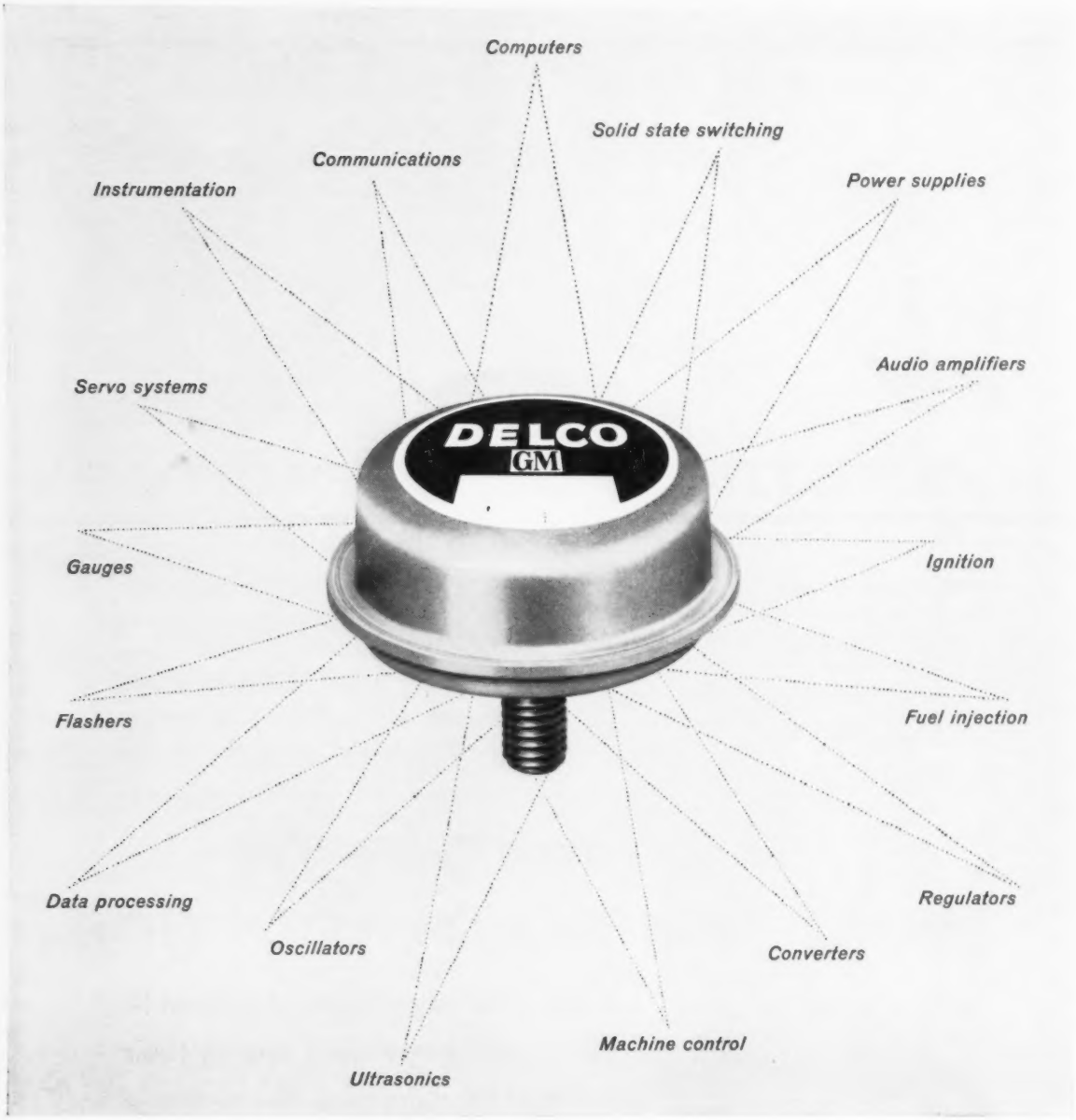
Engineering Bulletin TSC 119 gives full information.

SANGAMO

Electric Company

SPRINGFIELD, ILLINOIS

SC58-1



Wherever you require high power, consider

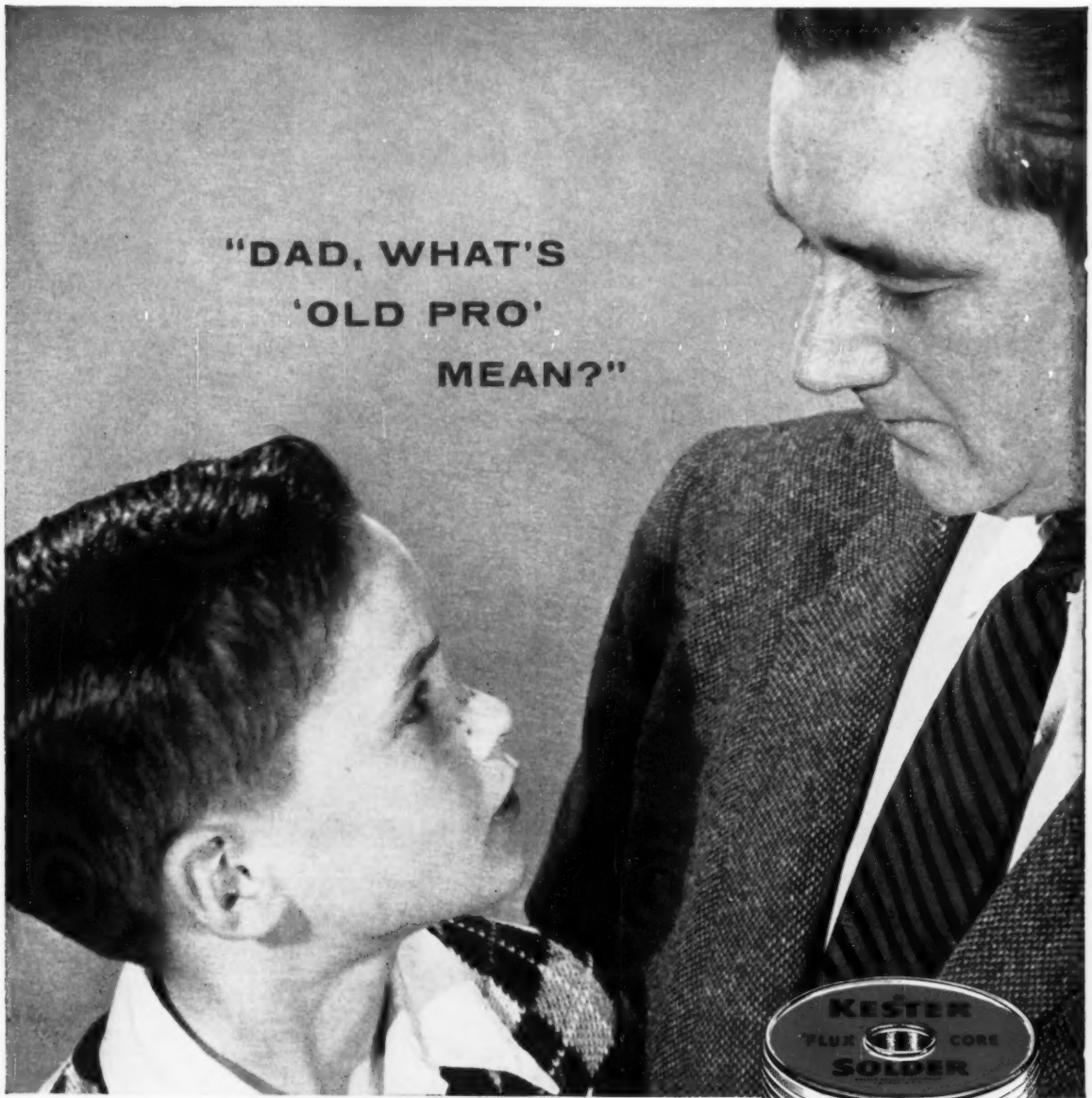
DELCO HIGH POWER TRANSISTORS

Thousands of Delco high power germanium transistors are produced daily as engineers find new applications for them. In switching, regulation, or power supplies—in almost any circuit that requires high power—Delco transistors are adding new meaning to compactness, long life and reliability.

All Delco transistors are 13-ampere types and, as a family, they offer a collector voltage range from 40 to 100 volts. Each is characterized by uniformly low saturation resistance and high gain at high current levels. Normalizing insures their fine performance and uniformity regardless of age. Also important—all Delco transistors are in volume production and readily available at moderate cost.

For complete data contact us at Kokomo, Indiana or at one of our conveniently located offices in Newark, New Jersey or Santa Monica, California. Engineering and application assistance is yours for the asking.

DELCO RADIO DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



KESTER FLUX-CORE SOLDER

Leave it to a child to get to the heart of the matter quickly. No gobbledygook or double-talk is going to turn him aside from his single-minded objective.

It's like that with solder. No meager test dependent upon a "sample" or even a "one-line operational test" is going to prove conclusively the merits of a "Johnny-come-lately" solder from that second source of supply. The wise buyer knows that the solder used on his production line must do the job he requires day-in and day-out without question.

And KESTER SOLDER has been time-tested and industry-proved for over 50 years.

That's what we mean by "old pro," Sonny!

SEND TODAY for your copy of the 78-page Kester textbook, "Solder ... Its Fundamentals and Usage." It's free!

KESTER SOLDER *Company* 4210 Wrightwood Avenue, Chicago 39, Illinois

Newark 5, New Jersey • Brantford, Canada

Circle 18 on Inquiry Card, page 97

What happens to soldered joints at "fifty below"?

"Dutch Boy" solder specialists tell how to make sure they hold when cold

Push temperature down and lead's strength goes up – without major loss in ductility.

Not so with tin. Below – 18°F, tin may suffer allotropic transformation. Gets brittle. Changes color.

Recent "Dutch Boy" research shows, as you might expect, that lead-tin solders tend to split this difference in rough proportion.

A 50-50 solder, for example, yields joints with higher tensiles at —75°F than at room temperature. But it's more brittle. At —75°F the joined metals still fail before the joint. Further down the temperature scale, joints fail first.

Increasing the lead content lowers the temperature at which joints retain good ductility. But strength does not increase as rapidly as temperatures go down.

Up to 15%, tin content has little effect on ductility. Beyond that, the loss in ductility (and in impact and fatigue resistance) that occurs as temperatures go below —18°F should be considered.

Allotropic change in tin may be inhibited with antimony

For makers of aircraft, missile and arctic electronic equipment, and for others whose products meet with extreme low temperatures, a recent proposed change in Government specs is of interest.

This proposal, which calls for 0.2 to 0.5% antimony in solders in the 40 to 70% tin range, is based on investigations showing that antimony inhibits allotropic change in tin as the thermometer falls.

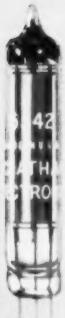
Your "Dutch Boy" Solder specialist is well informed on this and other frontier areas of solder technology now under investigation at National Lead Laboratories and elsewhere. Use his specialized knowledge freely. Or write National Lead Company, 111 Broadway, New York 6, N. Y.

Dutch Boy
SOLDER AND FLUXES

Specialists in special purpose tubes

THYRATRONS—An extensive line of thyratrons for use as grid control rectifiers, relays and noise generators. Inverse voltage ranges from 100 to 5,000 volts. Sizes from subminiatures to ST 16 bulbs. Filamentary as well as hot and cold cathode types are available.

RECTIFIERS—Both vacuum and gas filled tubes with peak inverse voltage ratings from 200 to 15,000 volts. Included are tubes with special features such as fast warm-up, cold cathodes, clipper service ratings and rugged construction.



VOLTAGE REGULATOR AND REFERENCE TUBES—Gas filled tubes designed to specific voltages for regulating small currents. Also used to make available stable reference voltages for high current supplies. Sizes from subminiatures to bantams, including many reliable, ruggedized types.

TWIN POWER TRIODES—The most complete line of high current twin power triodes developed especially for regulated power supply usage. Current and power ranges up to 800 milliamperes and 60 watts respectively. Included are rugged types in both low and medium mu construction.

TELEPHONE TYPES—A highly specialized line of vacuum and gas filled types in both the 300 and 400 series.

HYDROGEN THYRATRONS—Used primarily as switching tubes in line type radar modulators, these tubes permit accurate control of high energy pulses. Sizes from miniatures to the VC 1257. Peak pulse power ranges from 10 kilowatts to 33 megawatts.

Chatham research and development has produced many new tube types that have become industry standards. If you have a special purpose tube problem, Chatham experience can help you find the solution.

CHATHAM ELECTRONICS Division of **TUNG-SOL ELECTRIC INC.**

General Office and Plant: Livingston, New Jersey

SALES OFFICES: CHICAGO, DALLAS, LIVINGSTON, LOS ANGELES

NEW
KLEIN
shear cutting plier

207-5C shear cutting oblique plier 5½ inches long. Coil spring keeps jaws apart ready for use.

Here is the greatest advance in oblique cutters. This new Klein tool with shear blades is ideal for cutting hard wire such as tungsten filament or dead soft wire. Also recommended for cutting small bundles of wire. The shearing action assures easy, positive cutting at all times.

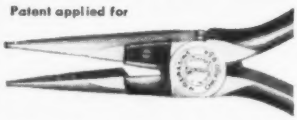
Regular cutters at the nose give added usefulness and convenience. The shear blade is easily replaceable. Plier never needs sharpening.

This plier is supplied with a coil spring to keep the handles in open position. Can also be had with Plastisol dipped handles if desired.

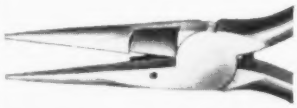
Write for full information

LONG NOSE SHEAR CUTTING PLIERS

Patent applied for



208-6C long nose shear cutting plier. A 6½-inch long nose plier with shear blades. Point of nose 1/16-inch diameter. Coil spring keeps jaws open ready for use.



208-6NC. Similar in design to 208-6C but reverse side designed to put a positive 3/16-inch hook on the end of a resistor wire. Smooth one-motion operation saves production time on every television or radio set.

FREE POCKET TOOL GUIDE

100 years of service to linemen, electricians and industry is back of this new Pocket Tool Guide No. 100. A copy will be sent you on request without obligation.

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7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

Tele-Tips

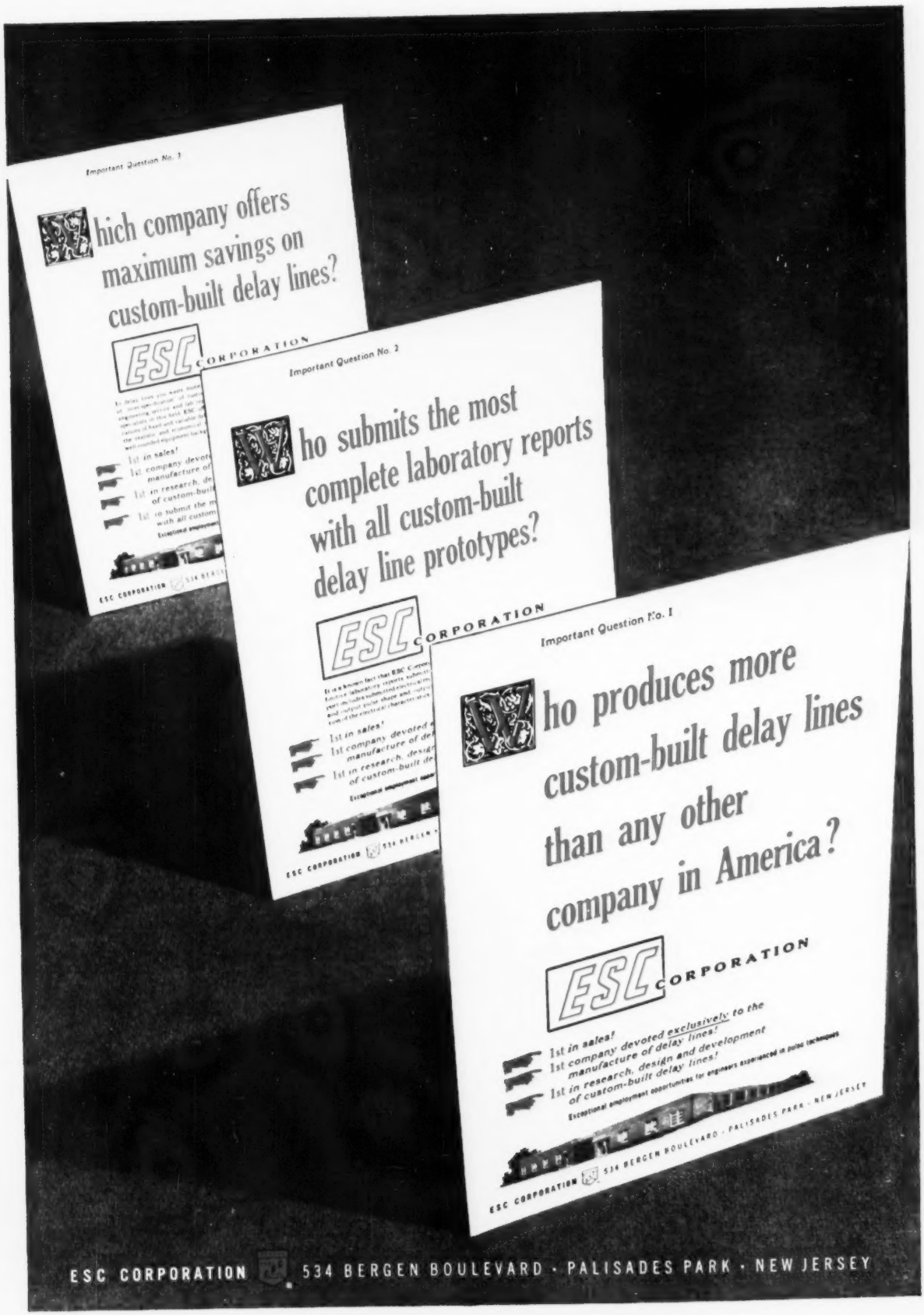
(*Continued from page 22*)

BELL LABS has developed a new device that can read hand-written numerals or identify numerals as they are being written. First application will be to the phone company's problem of handling long distance tickets. Each ticket contains 20 to 30 hand-written characters, and approximately two billion of these tickets are processed each year. Picking up this information by machine rather than by human eye will be a tremendous aid in preparing telephone bills.

"ACADEMIC ATROPHY" was the title hung on electrical engineering curriculums at a recent meeting at M.I.T. Dr. Gordon Brown called for a concerted action to throw away the "handbook" approach, to concentrate on understanding the principles rather than relying on pat formulas. Only in this way, he said, can engineers be made capable of contributing to each new development as it comes along.

"MACHINE - PICKED" JURIES will be the next field of application for electronic processing. IBM has designed a machine that will select eight jury panels of 275 names each in twenty minutes. The process formerly took two days. The machine went into operation last month at the Bergen City (N. J.) Courthouse in Hackensack, N. J. It even addresses subpoenas to the persons whose names are selected for the panels.

BRITISH PHONE subscribers are benefiting from the advanced technical skills but backward clerical practices of the British phone system. The new automatic dialing equipment makes it possible to dial numbers considerably distant, but the automatic accounting equipment has not yet been installed to register the tolls. So in many areas subscribers are making extended calls at a local charge.


Important Question No. 3
hich company offers maximum savings on custom-built delay lines?
ESC CORPORATION
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Exceptional employment opportunities for engineers experienced in pulse techniques
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March 24, 25, 26, 27, New York City

E-V now offers laboratory and production instruments, designed to meet internal needs or on contractual development assignments. Proven in use, all production is laboratory built and tested. Customizing service available for your special needs.

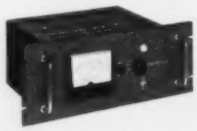
Model 6100 Laboratory Standard Microphone

Model 6100 Portable Preamplifier

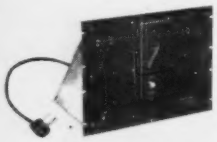
Model 6100R Rack-mounted Preamplifier

Model 6000 Transistor Decade Amplifier

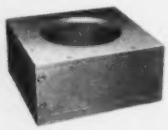
Model 6700 Portable Logarithmic Translator



Model 6700R Rack-mounted Logarithmic Translator

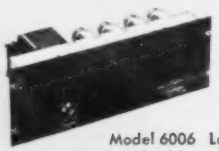


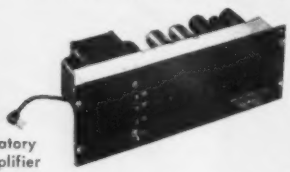
Model 6800 Magnetizer



Model 6898 Magnetizer Coil Assembly

Model 6899 Magnetizer Coil Assembly





Model 6006 Laboratory Standard Power Amplifier

Some Sales Territories Still Open.

Write for Literature.

ELECTRO-VOICE, INC.
Buchanan, Michigan

Instruments
Division of Electro-Voice

Letters

to the Editor

"Career Conference"

Editor, ELECTRONIC INDUSTRIES:

Editors seem frequently to be anxious about the uses to which articles in their magazine are given. Consequently, I thought you might be interested in the special use given the November 1957 issue of Electronic Industries and Tele-Tech. My copy arrived just before the scheduled event, so I had fresh data at hand—and I used it.

The Cleveland Technical Societies Council (44 member Societies) has for many years conducted an annual "Career Conference on Engineering and Science for High School Students." It has had the support and assistance of school authorities in Cleveland and many suburbs. Students are informed, given cards with personal data questions and space to indicate fields of interest and questions which they may have. The schools do this. On the scheduled night, a panel meets with the students, their parents and teachers at the school.

The program enclosed explains most of the system I believe. Of course, to divide the work, other people generally compose the panels at other schools so the names in their program reveal only those attending the session at Rocky River High School. Some do serve at other schools, but seldom can one get at all. Without growing "expansive"—W. C. Brown listed as counselor in Electrical Engineering is President of the Cleveland Engineering Society this year, and Colin Carmichael is Editor of Machine Design Magazine. He was the overall coordinator of this group. Ray Stanish, Thompson Products, Inc., is Chairman of the Committee on Educational and Vocational Guidance.

The work is an important one for the engineering profession and the CTSC plus its fine, active members are certainly doing a wonderful thing. But where does Electronic Industries enter? Look at the November, 1957 issue—

Page 42—"Pattern for Success."

Page 47—"Is Engineering Training Right for the Individual."

Page 107—Professional Opportunities—
"Engineer Shortage Continues, White House Aide Warns;"
"Distribution of Engineers;"
"Too Many Fail in Engineering Courses;"

(Continued on Page 36)

H. J. Birschel

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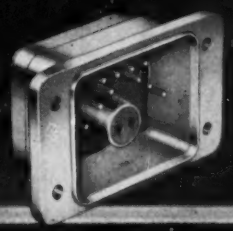
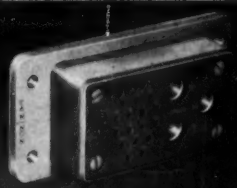
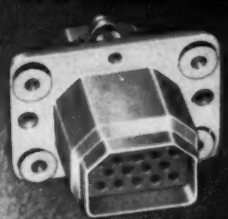
Rack-Panel-Chassis Connectors
for RAPID DISCONNECT
Faster Inspection... Faster Testing... Faster Servicing... Maximum Interchangeability

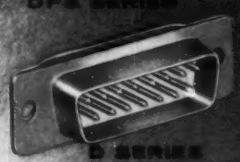




DP-A SERIES



DP-A SERIES



D SERIES

Cannon offers you more than 18 different basic designs in rack-panel-chassis connectors... designed with all the latest features to give you accurate alignment, easy mating, proper connection, and interfacial sealing where desired.

Select the connector you want in standard, miniature, or sub-miniature sizes... for standard circuitry or printed circuitry. Up to 156 contacts... and a great number of combinations of contacts for control, audio, thermocouple, co-ax, twin-ax, and pneumatic connections. In single- or double-gang. Some with shells, some without... all ruggedly constructed to take the many "in" and "out" operations of rack, panel, chassis, and sub-assembly applications. Special moisture-proof types. Standby units featuring gold-plated contacts to withstand deterioration and corrosion.

For an interesting discussion of the broad subject of "Reliability," write for Cannon Bulletin R-1.

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles, Salem, Mass., Toronto, Can., London, Eng., Melbourne, Austl. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities. **Please refer to Dept. 201.**

For **reliability** in your rack-panel-chassis connectors... connect with Cannon! Write for Bulletin DP-10 and DP-101 Supplement.

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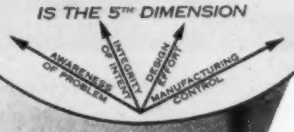
WHERE RELIABILITY IS THE 5TH DIMENSION



Circle 24 on Inquiry Card, page 97

The Customer is Always Right!

Whether you're one of the more than 50,000 radio-electronics engineers who will attend this year's convention and show or one of the 800-plus exhibitors, you made this what it is today. It's big... but just big enough to bring you all that's new in radio-electronics research and development!

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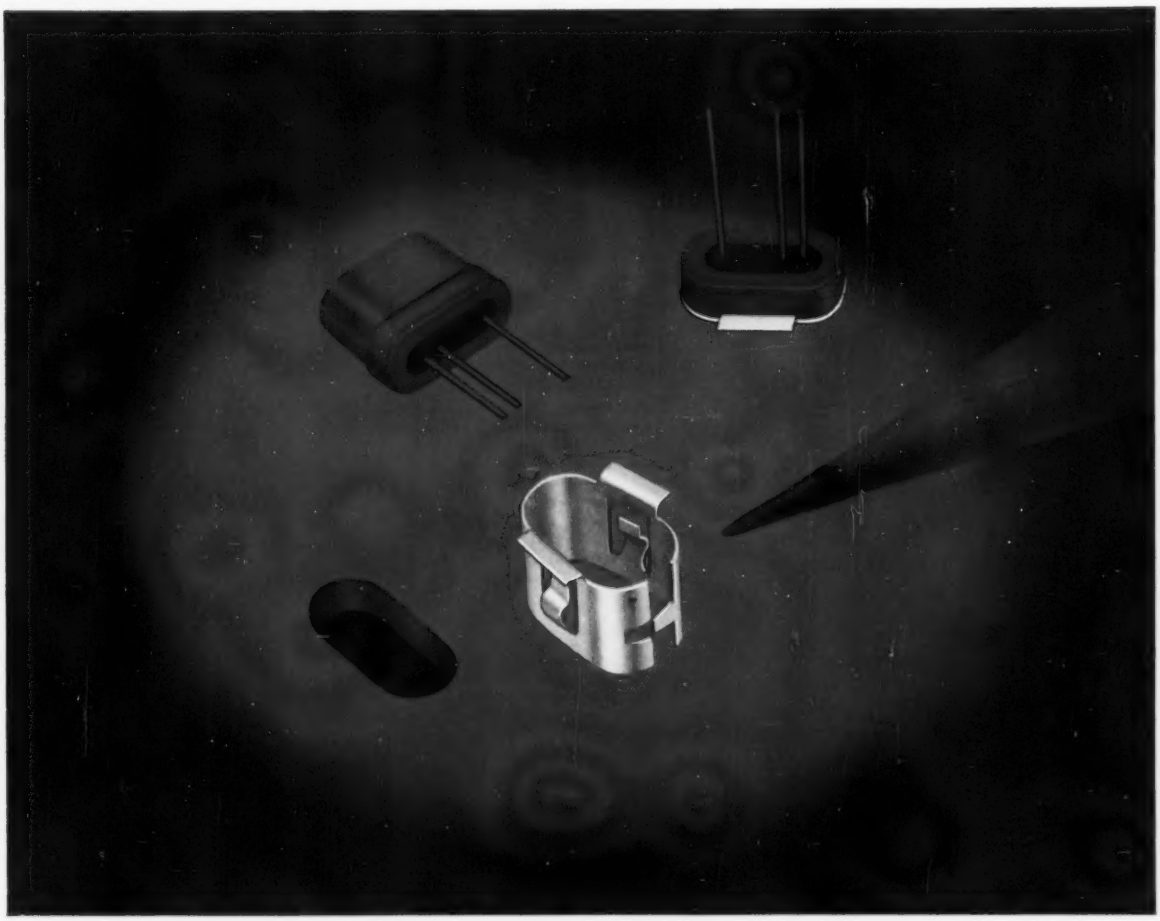

Engineered by Tinnerman...

Pea-size **SPEED CLIP**® saves space in missile, makes servicing of transistors easier

Tiny transistors that trigger the controls on a missile or supervise the sequencing on a jet engine are now plugged into pea-size Tinnerman SPEED CLIPS.

A thumb-push locks these front-mounting tubular SPEED CLIPS into punched holes in circuit panels. There's no soldering or riveting, no need for special tools. Spring-steel fingers hold tight; assure a vibration-free assembly. The fully encaged transistor is provided with excellent heat dissipation and can be readily removed for servicing. The SPEED CLIPS can be reused over and over again.

Tinnerman SPEED NUT® Brand Fasteners can save time and money on your production line, too, whether you require a specially engineered fastener or select one of the 9000 variations of existing designs. SPEED NUTS are easy to use, can be applied quickly anywhere along your production line, assuring quality, vibration-proof attachments at low cost.

Discuss your fastening needs with your Tinnerman representative . . . he'll have SPEED NUT ideas to help you make an even better product, at lower cost. You'll find him listed in all major telephone directories. Or write to:

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FASTEST THING IN FASTENINGS®

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the mighty nine plus two!

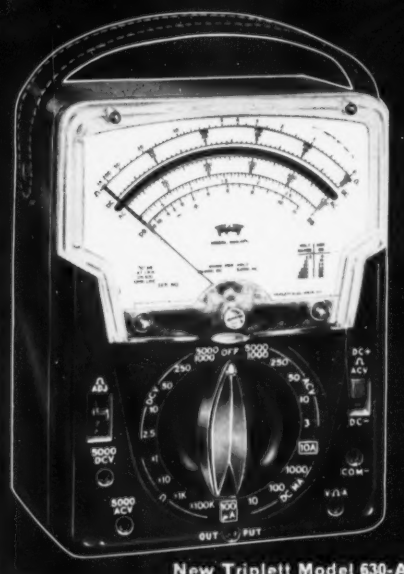
New Triplett Model 630-PL

TWO NEW VOLT-OHM-MILLIAMMETERS

Now the Triplett Mighty Nine Has Expanded to A Line of 11 VOMs Tailored to Meet Your Preference, Purse or Purpose. Only Triplett Offers So Complete A Variety.

With the new 630-PL and 630-APL you get these important new features:

- Voltage scales for those who want ranges reading by 10's (2.5-10-50-250-1000-5000).
- Instant-vision, wider spread scales; streamlined case, handsome modern design.



New Triplett Model 630-APL

- D.C. Polarity Reversing Switch.
- 5 to 500,000 Cycles per second frequency response in A.C. measurements.
- 5000 ohms per volt sensitivity in A.C. ranges; 20,000 ohms per volt D.C.

Both new testers — with the popular continued Models 630 and 630-A—offer these proved Triplett advantages:

- One switch will select any range; minimizes chance of incorrect settings and burnouts.
- Reads from .1 ohm (4.4 ohm center scale) to 100 megohms; four ranges.
- Molded circuit panel for instant component replacement.
- Models 630-APL and 630-A feature ½% resistors for greater accuracy; long mirrored scales to eliminate parallax in reading.
- Banana-type leads for low contact resistance at jacks.

how do you want it?

X 3s or X 10s

Triplett Models 630 and 630-A read volts 0-3-12-60-300-1200-6000); or Triplett New Models 630-PL and 630-APL reading 2.5-10-50-250-1000-5000.

Choose your preference in range reading.

MODEL 630-PL . . . Dealer Net $44.50
MODEL 630-APL . Dealer Net $54.50
MODEL 630 . . . . . Dealer Net $44.50
MODEL 630-A . . . . Dealer Net $54.50

Only Triplett offers 11 VOM's — a line complete enough to give you exactly what you want.

Triplett Model 630

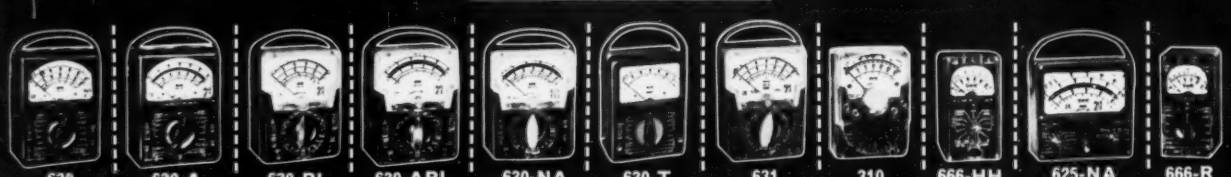
TRIPLETT

Triplett Electrical Instrument Co.
Bluffton, Ohio

53 Years of Experience

Triplett Model 630-A

Burton Browne Advertising

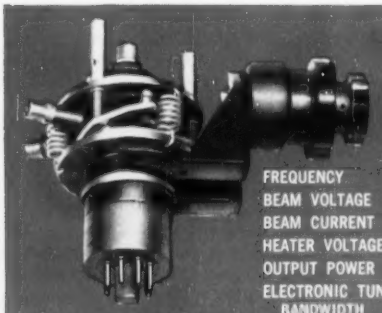


630 630-A 630-PL 630-APL 630-NA 630-T 631 310 666-HH 625-NA 666-R

SPERRY 2K SERIES KLYSTRONS COVER

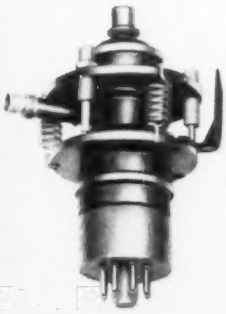
Continuous frequency range from 2660 to 10,300 mc

In wide use in the laboratory and on the production line



2K41 OPERATING SPECIFICATIONS

FREQUENCY	2,660 to 3,310 mc
BEAM VOLTAGE	300 to 1,250 v
BEAM CURRENT	15 to 60 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	0.02 to 2.75 w
ELECTRONIC TUNING BANDWIDTH	5 to 17 mc

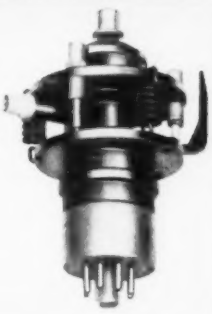


2K42 OPERATING SPECIFICATIONS

FREQUENCY	3,300 to 4,200 mc
BEAM VOLTAGE	300 to 1,250 v
BEAM CURRENT	6 to 50 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	30 to 1,450 mw
ELECTRONIC TUNING BANDWIDTH	15 to 30 mc

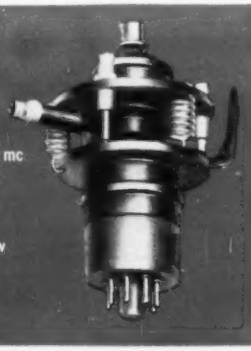
2K43 OPERATING SPECIFICATIONS

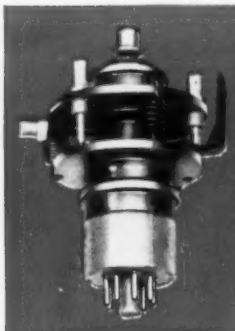
FREQUENCY	4,200 to 5,700 mc
BEAM VOLTAGE	500 to 1,250 v
BEAM CURRENT	12 to 50 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	0.25 to 1.25 w
ELECTRONIC TUNING BANDWIDTH	25 to 50 mc



2K44 OPERATING SPECIFICATIONS

FREQUENCY	5,700 to 7,500 mc
BEAM VOLTAGE	500 to 1,250 v
BEAM CURRENT	14 to 54 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	50 to 1,025 mw
ELECTRONIC TUNING BANDWIDTH	10 to 70 mc





2K39 OPERATING SPECIFICATIONS

FREQUENCY	7,500 to 10,300 mc
BEAM VOLTAGE	500 to 1,250 v
BEAM CURRENT	12 to 35 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	0.25 to 1 w
ELECTRONIC TUNING BANDWIDTH	20 to 40 mc

2K25 OPERATING SPECIFICATIONS

FREQUENCY	8,500 to 9,660 mc
BEAM VOLTAGE	300 v
BEAM CURRENT	32 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	3 to 20 mw
ELECTRONIC TUNING BANDWIDTH	25 to 115 mc

Sperry is currently producing, for immediate delivery, a wide range of Series 2K Reflex Oscillator Klystron Tubes.

Especially suited for use in laboratory test equipment, as signal generators and bench oscillators, the 2K tubes are also used in production line testing and in radar equipment. Design features include integral cavity and tuner, convenient modulation, simple single-screw tuning and extra-rugged construction for long service life.

Write or phone the nearest Sperry district office for more details on these and other Sperry Klystrons.

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← Circle 27 on Inquiry Card, page 97

Circle 28 on Inquiry Card, page 97

the mighty nine plus two!

New Triplett Model 630-PL

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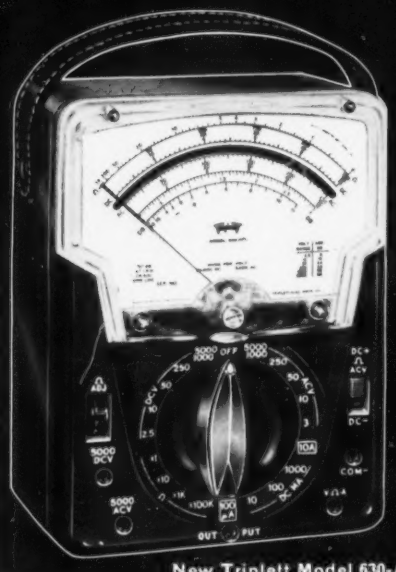

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- One switch will select any range; minimizes chance of incorrect settings and burnouts.
- Reads from .1 ohm (4.4 ohm center scale) to 100 megohms; four ranges.
- Molded circuit panel for instant component replacement.
- Models 630-APL and 630-A feature ½% resistors for greater accuracy; long mirrored scales to eliminate parallax in reading.
- Banana-type leads for low contact resistance at jacks.

how do you want it?

X 3s or X 10s

Triplett Models 630 and 630-A read volts 0-3-12-60-300-1200-6000); or Triplett New Models 630-PL and 630-APL reading 2.5-10-50-250-1000-5000.

Choose your preference in range reading.

MODEL 630-PL . . . Dealer Net $44.50
MODEL 630-APL . Dealer Net $54.50
MODEL 630 . . . . . Dealer Net $44.50
MODEL 630-A . . . . Dealer Net $54.50

Only Triplett offers 11 VOM's — a line complete enough to give you exactly what you want.

TRIPLETT

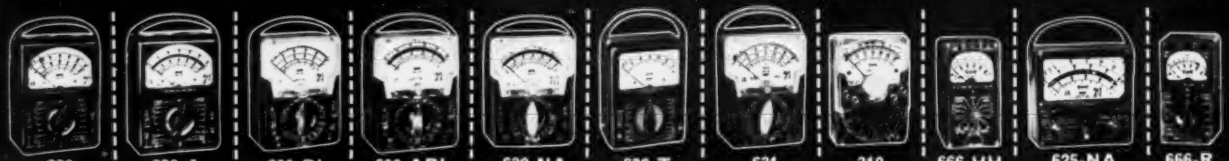
Triplett Electrical Instrument Co.
Bluffton, Ohio

53 Years of Experience

Triplett Model 630

Triplett Model 630-A

Burton Browne Advertising

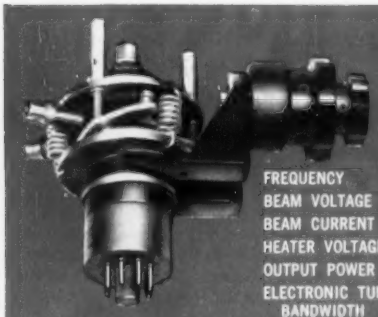


630 630-A 630-PL 630-APL 630-NA 630-T 631 310 666-HH 625-NA 666-R

SPERRY 2K SERIES KLYSTRONS COVER

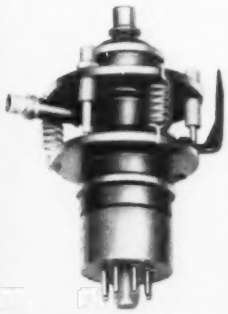
Continuous frequency range from 2660 to 10,300 mc

In wide use in the laboratory and on the production line



2K41 OPERATING SPECIFICATIONS

FREQUENCY	2,660 to 3,310 mc
BEAM VOLTAGE	300 to 1,250 v
BEAM CURRENT	15 to 60 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	0.02 to 2.75 w
ELECTRONIC TUNING BANDWIDTH	5 to 17 mc

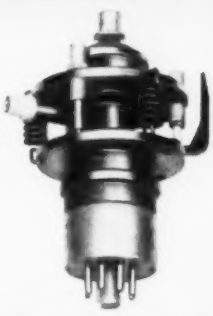


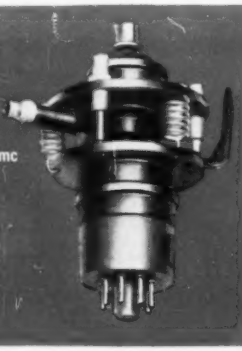
2K42 OPERATING SPECIFICATIONS

FREQUENCY	3,300 to 4,200 mc
BEAM VOLTAGE	300 to 1,250 v
BEAM CURRENT	6 to 50 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	30 to 1,450 mw
ELECTRONIC TUNING BANDWIDTH	15 to 30 mc

2K43 OPERATING SPECIFICATIONS

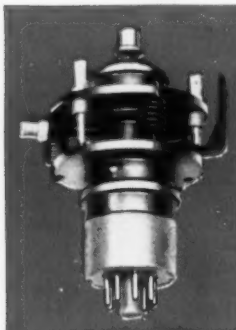
FREQUENCY	4,200 to 5,700 mc
BEAM VOLTAGE	500 to 1,250 v
BEAM CURRENT	12 to 50 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	0.25 to 1.25 w
ELECTRONIC TUNING BANDWIDTH	25 to 50 mc





2K44 OPERATING SPECIFICATIONS

FREQUENCY	5,700 to 7,500 mc
BEAM VOLTAGE	500 to 1,250 v
BEAM CURRENT	14 to 54 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	50 to 1,025 mw
ELECTRONIC TUNING BANDWIDTH	10 to 70 mc



2K39 OPERATING SPECIFICATIONS

FREQUENCY	7,500 to 10,300 mc
BEAM VOLTAGE	500 to 1,250 v
BEAM CURRENT	12 to 35 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	0.25 to 1 w
ELECTRONIC TUNING BANDWIDTH	20 to 40 mc

2K25 OPERATING SPECIFICATIONS

FREQUENCY	8,500 to 9,660 mc
BEAM VOLTAGE	300 v
BEAM CURRENT	32 ma
HEATER VOLTAGE	6.3 v
OUTPUT POWER	3 to 20 mw
ELECTRONIC TUNING BANDWIDTH	25 to 115 mc

Sperry is currently producing, for immediate delivery, a wide range of Series 2K Reflex Oscillator Klystron Tubes.

Especially suited for use in laboratory test equipment, as signal generators and bench oscillators, the 2K tubes are also used in production line testing and in radar equipment. Design features include integral cavity and tuner, convenient modulation, simple single-screw tuning and extra-rugged construction for long service life.

Write or phone the nearest Sperry district office for more details on these and other Sperry Klystrons.

ELECTRONIC TUBE DIVISION

SPERRY GYROSCOPE COMPANY

Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN · CLEVELAND · NEW ORLEANS · LOS ANGELES
SAN FRANCISCO · SEATTLE · IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LTD., MONTREAL, QUEBEC.

← Circle 27 on Inquiry Card, page 97

Circle 28 on Inquiry Card, page 97

REDUCE INSERTION LOSS!! INCREASE USABLE POWER!!

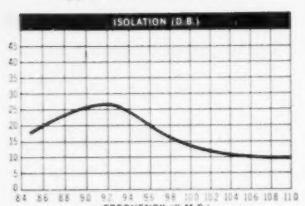
NEW

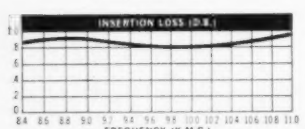
Kearfott

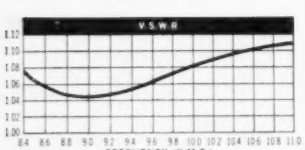
MIDGET

FERRITE ISOLATOR

Typical Performance Curves







MAXIMUM FREQUENCY STABILITY WHERE SPACE IS LIMITED...

A high power unit of exceptionally small size and weight, this newest Kearfott product is the answer to microwave circuitry applications where space is limited.

IMPORTANT FEATURES:

BROAD FREQUENCY RANGE—from 8.5 to 9.6 KMC
HIGH ISOLATION—Minimum of 15 DB
INSERTION LOSS—Only 1.0 DB Maximum
SMALL SIZE—1.000" deep x 2.100" high x 2.400" high
POWER—Average 200 Watts
TEMPERATURE-AMB—150°C
PRICE—$135.00 each f.o.b., Van Nuys, Calif. Quantity prices on request
DELIVERY—from stock

OTHER STANDARD Ferrite Isolators and Duplexers in a wide range of sizes and band widths are available plus facilities to produce special configurations if desired. Our sales engineers can help you.

Kearfott COMPANY, INC.
LITTLE FALLS, NEW JERSEY
WESTERN DIVISION
MICROWAVE DEPARTMENT
A SUBSIDIARY OF GPE
DEPT. 13-B, 14844 OXNARD ST. • VAN NUYS, CALIF.

SALES OFFICES:
Eastern Office: 1378 Main Ave. Clifton, N. J.
Midwest Office: 188 W. Randolph St. Chicago, Ill.
South Central Office: 6115 Denton Drive Dallas, Texas
Northwest Area Office: 530 University Ave. Palo Alto, Calif.

Letters

to the Editor

(*Continued from Page* 30)

"Government Opens Tests to College Juniors."

Page 108—"The New E. E. Looks at Industry," by Mr. M. S. Oldacre, Dr. John D. Ryder, and Dr. S. Reid Warren, Jr.

The data was shown other counselors and panel members, and indicated to the Electrical Group. Some was used in answering questions. Many came afterward and looked, took notes or said they would look up some of the information themselves. Fortunately, the arrival of Electronic Industries was most appropriate and timely, and the data was helpful, factual and well presented. I am sure that my one copy gave—through its use—sufficient to warm the cockles of the heart of any "hard boiled" editor and his authors and the financial backers of the magazine.

Sorry to talk so long—but I did think you might want to know what a good thing the CTSC is and how well E. I. assisted. (Then of course there was lots more in the issue I haven't mentioned about work, products, etc.). Then, too, how can one put on the little line on your check-up card, what I have tried to indicate in these many pages?

Thanks for your help.

Harold D. Seilstad
Cdr. U. S. C. G.
2022 Belle Ave.,
Lakewood 7, Ohio

"Youth Programs"

Editor, ELECTRONIC INDUSTRIES:

I have just read your article entitled "'Sputnik'—Guide for the U. S.!" in November Electronic Industries in which you enumerate several organizations for the advancement of science and engineering education.

There is now in existence an organization in every state and nearly every county of our nation sponsored by our national government and paid for in part by tax dollars which could, with very little additional effort, be made to fulfill your expressed desires. This organization is the 4-H Club. It is at present an agricultural-minded organization for boys and girls over 10 and under 21.

I believe if you investigate sufficiently you will be impressed at its past performance and its future possibilities.

Howard M. Fuller
928 East St.,
East Mansfield, Mass.

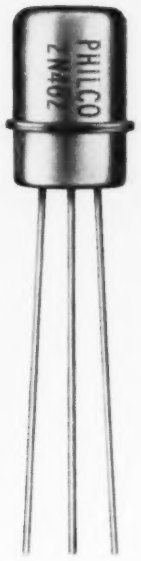
Ed. note: We're investigating!

(*Continued on Page* 141)

Circle 29 on Inquiry Card, page 97
Circle 30 on Inquiry Card, page 97 ⟶

FIRST FROM PHILCO

New Bilateral Transistor!



PHILCO 2N462

Bilateral alloy junction PNP transistor with controlled pulse response. (Shown greatly enlarged)

Outstanding Transistor Performance With Current Flow IN EITHER DIRECTION!

This transistor represents a new concept in semiconductor electronics and is available in production quantities. Emitter and collector are completely interchangeable. Performance characteristics meet the same specifications in either direction of current flow.

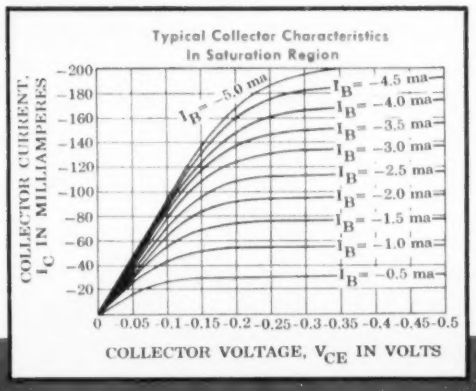
The new Philco 2N462 features high current (200ma), high gain (typical beta 45 in each direction), high voltage (40v), low saturation voltage—with controlled turn-on and turn-off times.

This revolutionary new transistor is exceptionally well suited to complementing circuitry, and for use in circuits where reversing the direction of the controlled current is desirable. The 2N462 has been used successfully in computers, communications equipment, multiplexing devices, and for bi-directional switching and phase detection systems.

Perhaps this new transistor can help solve a specific design problem for you. Our engineers cordially invite your inquiries.

Make Philco your prime source of information for all transistor applications.

Write to Lansdale Tube Company, Division of Philco Corporation Lansdale, Pa., Dept. EI-258

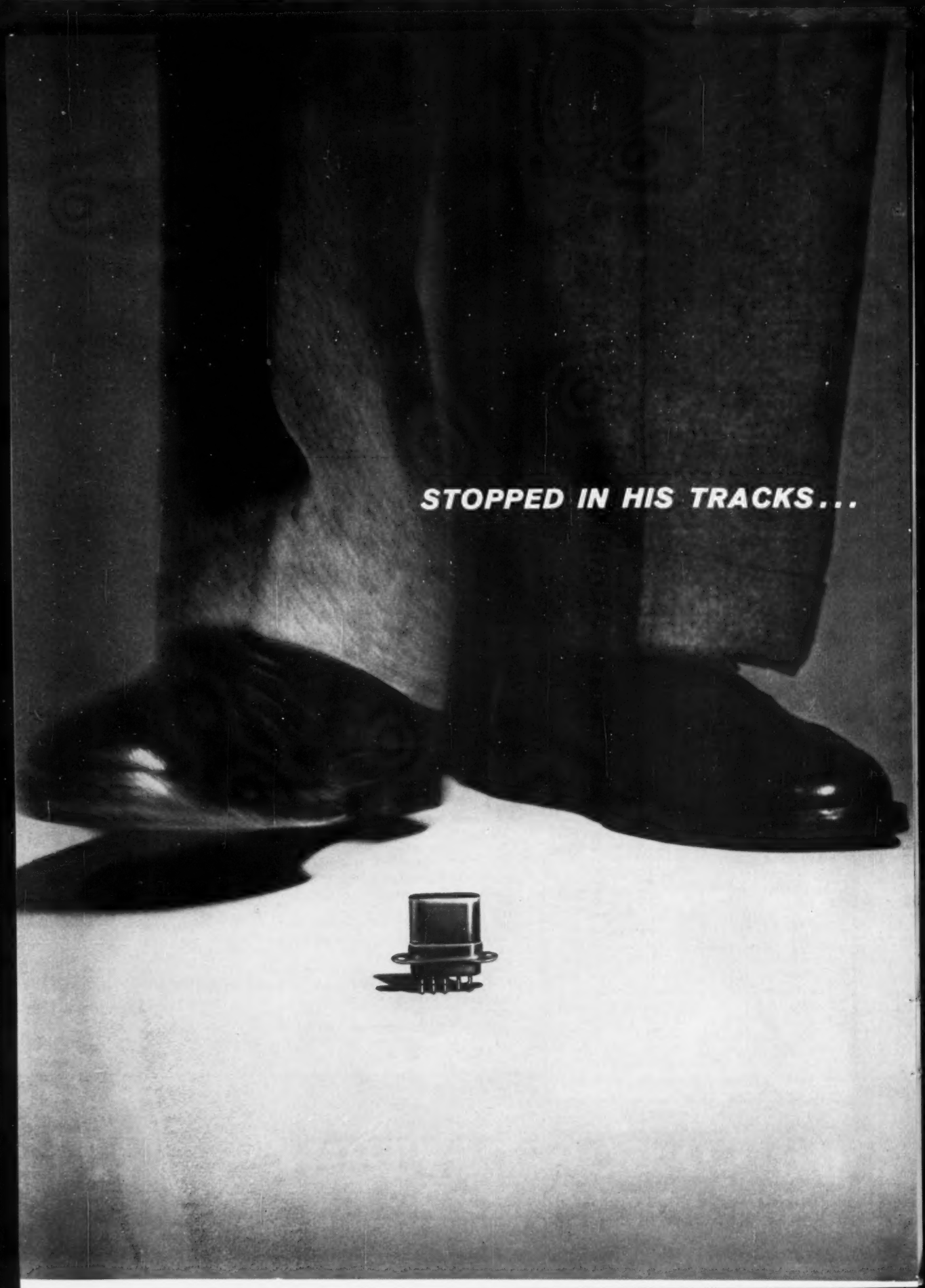


PHILCO® CORPORATION

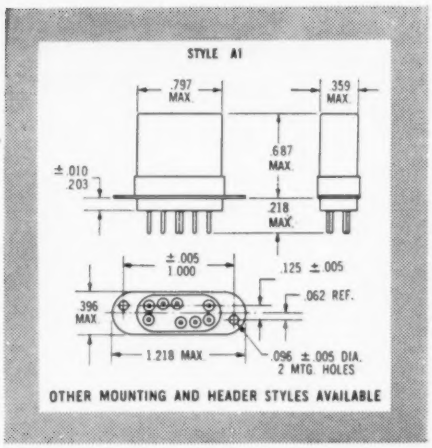
LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.


STOPPED IN HIS TRACKS...

Now! A West Coast Office
For Immediate Service



BURTON BROWNE/New York

BY THE NEW POWRMITE®

Filtors new and greatly advanced micro-miniature relay.

Filtors, the leading specialists in the development and manufacture of sub-miniature relays is proud to announce the addition of the new Powrmite micro-miniature relay to its existing line of traditionally outstanding relays.

In every field of achievement there is always one leader. In relays with highest available reliability the leader is Filtors, Incorporated. All of the experience and know how gained in attaining its position of leadership have gone into making Filtors new Powrmite micro-miniature relay *truly reliable*—again the leader in a field of many.

MICRO-MINIATURE SPECIFICATIONS

AMBIENT TEMPERATURE RANGE	–65°C. TO +125°C.
DIELECTRIC STRENGTH	1000 VOLTS. (750 VOLTS BETWEEN OPEN CONTACTS).
INSULATION RESISTANCE	10,000 MEGOHMS MINIMUM AT 25°C.
CONTACT ARRANGEMENT	2C (2 POLE DOUBLE THROW).
CONTACT RATING	2 AMPS RESISTIVE AT 28 VOLTS DC OR DRY CIRCUITS.
SHOCK	50 Gs 11 MILLISECONDS.
VIBRATION	10 – 55 CPS AT .06 AMPLITUDE. 55 – 2000 CPS AT 20 G.
PICK-UP TIME	7 MILLISECONDS MAXIMUM AT NOMINAL COIL. VOLTAGE, 25°C. TEMPERATURE.
RELEASE TIME	7 MILLISECONDS MAXIMUM.
NOMINAL COIL VOLTAGE	26.5 VOLTS DC.
COIL RESISTANCE	550 OHMS ±10% AT 25°C.
ALTITUDE	70,000 FEET.
DUTY	CONTINUOUS.
PICK-UP	RELAY SHALL PICK-UP WHEN COIL VOLTAGE IS 18 VOLTS DC OR LESS OVER THE AMBIENT TEMPERATURE RANGE.

Leading manufacturers of hermetically sealed micro and sub-miniature relays.

FILTORS, INC.

Main office and plant: Port Washington, N. Y., POrt Washington 7-8220
West coast office: 13273 Ventura Blvd., Studio City, Cal., STanley 3-2770

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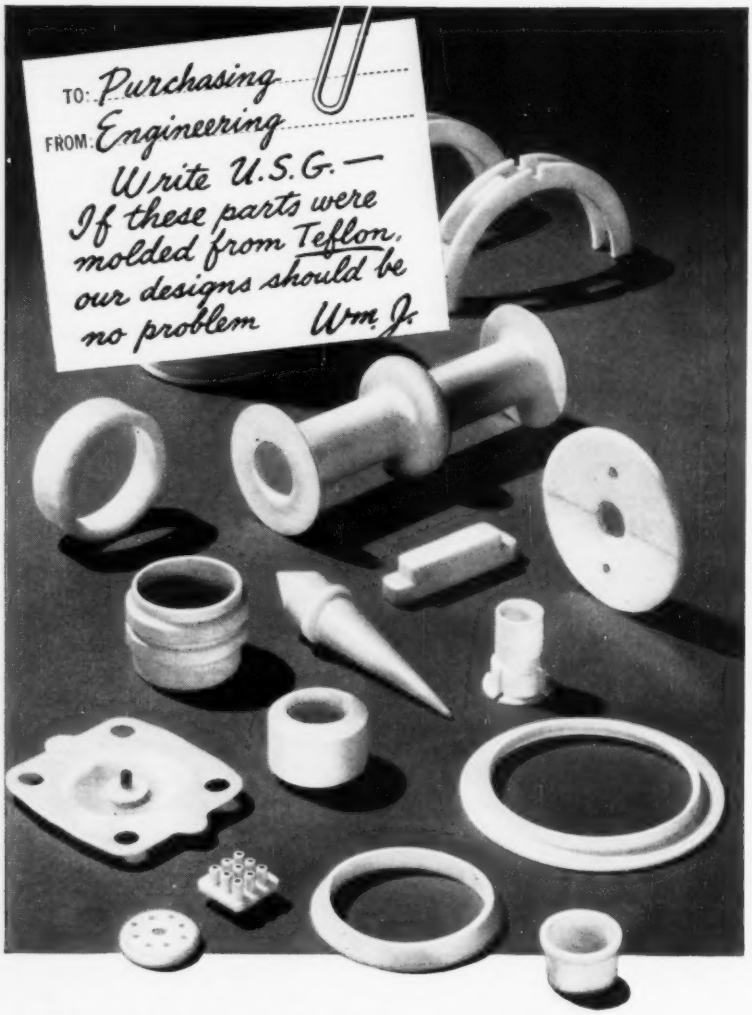


Never underestimate the molding possibilities of TEFLON*, in the hands of United States Gasket.

True, it is probably the most difficult of all plastics to mold. But U.S.G. specializes in difficult moldings, involving precision tolerances, intricate shapes, inserts, molding around metallic structures, etc.

They are equipped with unusual "know-how" gained as pioneers and leaders in fluorocarbon plastics fabrication, and the most modern specialized facilities and techniques for cold molding and sintering of TEFLON T.F.E., as well as the injection molding of KEL-F† and the new thermoplastic TEFLON F.E.P.

Send us your difficult fluorocarbon molding problems for quotations. And call upon us, too, for your requirements of fluorocarbon and nylon sheets, discs, tape, rods, tubing, bars, cylinders, etc., from the world's largest and most complete stocks.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

†*M.M.&M. Trademark*
**du Pont Trademark*

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

Books

Soviet Education for Science and Technology

By Alexander G. Korol. Published 1957 jointly by Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., 440 4th Ave., New York 16. 540 pages. Price $8.50.

This book reveals the facts behind an educational system whose graduates in science and engineering are in large measure responsible for some of the most startling scientific developments of the decade. The announcement made in 1957 of the first successful launching of an artificial satellite compels us to look closely at Soviet scientists, and, in turn, the system that produces them. In this book, the author examines the Soviet education—its structure, its strengths and weaknesses, and its potentialities—as it reflects the objectives and rationale of Soviet Communism.

In his appraisal of Soviet training the author had the benefit of a detailed study made by prominent American educators of Soviet curricula examinations, and text books. His findings are directly related to current problems of American education and raise some important questions about American educational aims.

Electronic Designers Handbook

By R. W. Landee, D. C. Davis, and A. P. Albrecht. Published 1957 by McGraw-Hill Book Co., 330 W. 42nd St., New York 36. 1200 pages. Price $16.50.

This handbook gives the fundamentals and data to aid in the design of all types of electronic equipment. It presents both the theoretical aspects of the subject and detailed practical design information, including technical discussions, design examples, and graphical and tabular data that may be used in design work.

The entire electronic field is covered in 23 big sections ranging from vacuum tube fundamentals and voltage and power amplifiers to such topics as computer and servomechanism techniques and waveform and network analysis.

Elements of Magnetic Tape Recording

By N. M. Haynes. Published 1957 by Prentice-Hall, Inc., 70 Fifth Ave., New York 11. 405 pages. Price $7.95.

This book combines the basic information about magnetic sound recording with all the latest developments in the field. The author describes the fundamentals, nomenclature, apparatus, and techniques of repair and maintenance involved in operating a superior tape recording system. The reader will learn what to look for in buying or building his own tape recorder. Numerous diagrams, charts, and photographs are included.

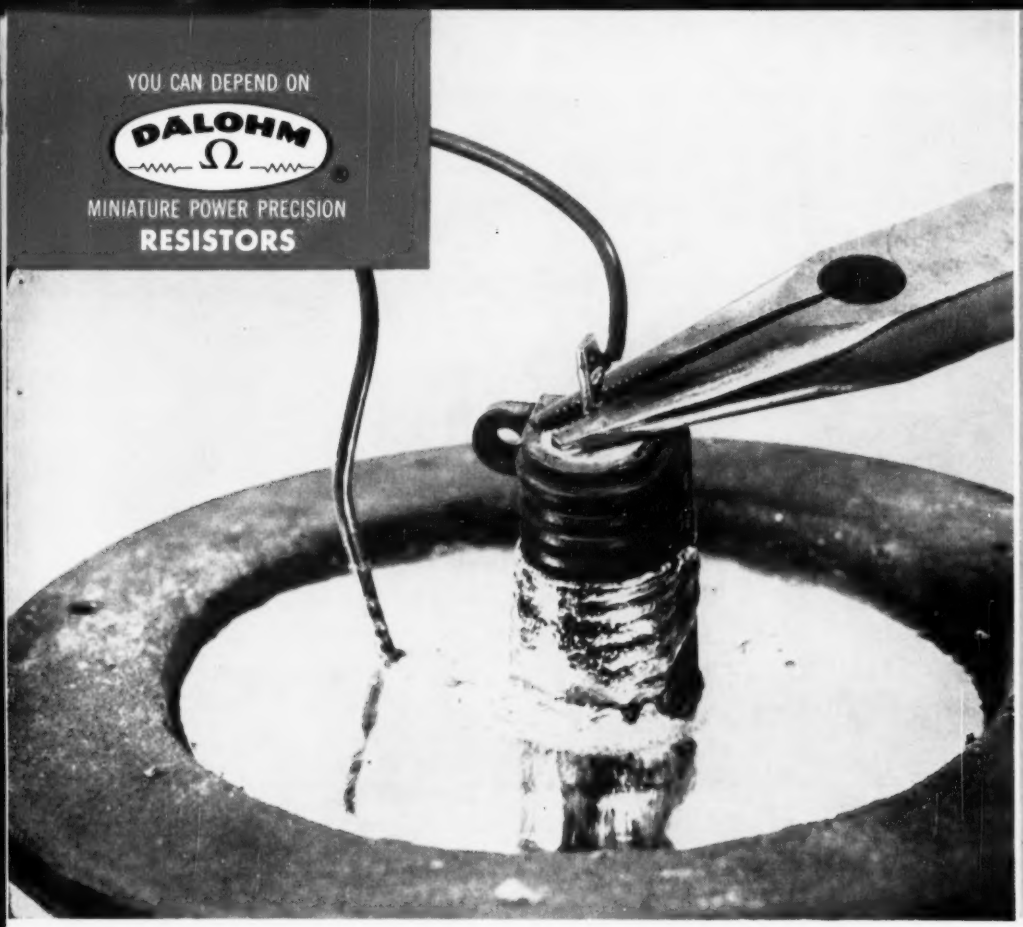
(*Continued on page* 44)

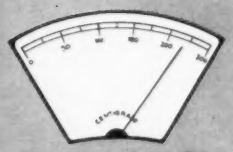
YOU CAN DEPEND ON

DALOHM Ω

MINIATURE POWER PRECISION

RESISTORS

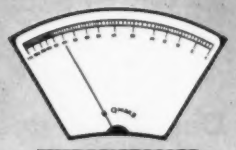




HI-TEMPERATURE
– 65° C to + 275° C

HI-PRECISION
± 0.05% to ± 3%

HI-WATTAGE
10 to 250 WATTS



HI-RESISTANCE
0.1 Ohm to 100K Ohms

Dipped in MOLTEN SOLDER . . . yet retains 100% reliability!

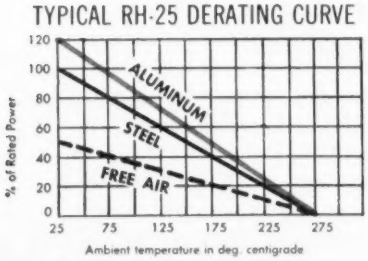
Most requirements for DALOHM RH and PH wire wound resistors will not be as severe as the molten solder dip shown above. But, here are the tough parameters RH and PH types will meet.

- Operating temperature range: – 65° C. to 275° C.
- Precision tolerance range: ± 0.05%, ± 0.1%, ± 0.25%, ± 0.5%, ± 1% and ± 3%.
- Powered at 10, 25, 50, 100 and 250 watts.
- Resistance range from 0.1 Ω to 100,000 Ω.
- Surpasses requirements of MIL-R-18546B
- Temperature coefficient: 0.00002/degree C.
- Complete protection from vibration, moisture and salt spray.
- Insulation breakdown: 1000 V AC or DC.

RH-10

10 watts, derating to 0 at 275° C.; 5 Ω to 30K Ω; ± 0.05% to ± 3%. Max. Working voltage: 500 volts.

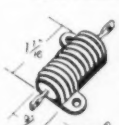
TYPICAL RH-25 DERATING CURVE



DALOHM RH and PH resistors are advanced design wire wound precision power resistors for applications under severe operating conditions, coupled with tight space requirements. These miniature powerhouse resistors offer complete protection from mechanical shock, vibration, moisture and salt spray.

DALOHM four point "ruggedized" construction provides 100% reliability with: 1. Precision wire wound resistor element. 2. All welded construction from terminal to terminal. 3. Suspension in special shock absorbing compound. 4. Insertion and sealing in radiator finned, anodized aluminum housing for maximum heat dissipation on panel mounting.

Careful advanced production techniques, backed by years of experience, and total progressive inspection assure reliability in all DALOHM resistors.



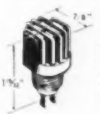
RH-25
25 watts, derating to 0 at 265° C.; 1 Ω to 15K Ω; ± 0.05% to ± 3%. Max. Working Voltage: 800

RH-50
50 watts, derating to 0 at 265° C.; 3 Ω to 100K Ω; ± 0.05% to ± 3%. Max. working voltage: 1000 V DC or AC

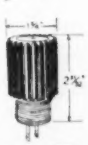
RH-250
250 watts, derating to 0 at 265° C.; 3 Ω to 35K Ω; ± 0.05% to ± 3%. Max. working voltage: 1000 V DC or AC

PH TYPE

New hole mounted power resistor in shock absorbing compound and in black anodized aluminum radiator finned housing.



PH-25
25 watts, derating to 0 at 265° C.; 1 Ω to 60K Ω; ± 0.05% to ± 3%. Max. working voltage: 800 V DC or AC



PH-100
100 watts, derating to 0 at 275° C.; 5 Ω to 35K Ω; ± 0.05% to ± 3%. Max. working voltage: 1000 V DC or AC.

JUST ASK US

DALOHM line includes a complete selection of precision wire wound, power and precision deposited carbon resistors. Also trimmer potentiometers, precision wire wound and deposited carbon; and collet fitting knobs. Write for free catalog.

If none of DALOHM standard line meets your need, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production. Just outline your specific situation.

DALE PRODUCTS, INC.
1304 28th Ave.
Columbus, Nebr., U.S.A.

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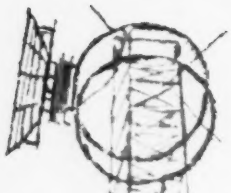

NEW!

BLAW-KNOX TOWERS FOR MICROWAVE SYSTEMS

Here is a new 10 page Bulletin prepared especially to provide answers to your specific questions on—

"What type tower do I need?"
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B1173	3"	5 1/8"	Elect.	Mag.	7/8"	7KV	70°	Alum.
K1517	3"	6 3/8"	Elect.	Mag.	7/8"	8KV	Off Center Neck	Alum.
5BCP—	5"	7"	Mag.	Mag.	7/8"	8KV	70°	Reg.
B1174	5"	6 5/16"	Elect.	Mag.	7/8"	8KV	70°	Alum.
B1142	7"	8 1/2"	Mag.	Mag.	7/8"	8KV	70°	Reg.
B1175	7"	7 13/16"	Elect.	Mag.	7/8"	10KV	70°	Alum.
B1191	10"	10 5/16"	Elect.	Mag.	7/8"	10KV	70°	Alum.
B1132	10"	12 1/2"	Elect.	Mag.	1 7/16"	10KV	78°	Reg.

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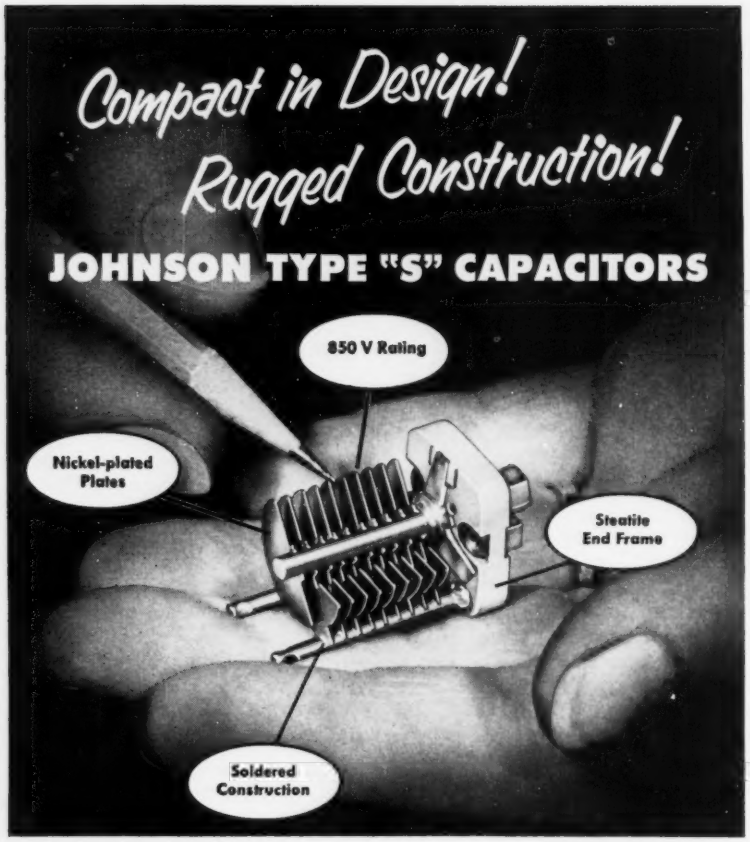

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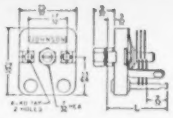

Cat. No.	Type No.	Capacity per Section Max.	Min.	Plates per Sec.	L
148-1	15S8	15	2.3	6	53/64"
148-2	25S8	25	2.6	10	1 3/16"
148-3	35S8	35	2.9	14	1 1/2"
148-4	50S8	50	3.2	19	1 9/64"
148-5	75S8	75	3.9	29	1 13/32"
148-6	100S8	100	4.5	38	1 43/64"

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Books

(*Continued from page 40*)

Progress in Semiconductors, Vol. II

Edited by A. F. Gibson, P. Aigrain, R. E. Burgess. Published 1957 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 14. 287 pages. Price $10.50.

At the present time, when hundreds of papers on semiconductors and allied subjects are published every year, it is difficult for any one specialist to read more than a small fraction if he is to leave any time for original work. This is true even with papers in his own particular field, and it is almost impossible for him to keep abreast of developments in related subjects, developments which may have considerable bearing on his own work.

This annual series of volumes is planned to meet this difficulty. A limited number of topics taken from a whole field of semiconductors will be included each year. The articles generally will be critical reviews, giving an assessment of the present state of knowledge. Some, however, will contain significant amounts of original work.

Transistor Electronics

By David DeWitt and Arthur L. Rossoff. Published 1957 by McGraw-Hill Book Co., 330 W. 42 St., New York 36. 392 pages. Price $8.00.

This book is planned to provide a thorough familiarity with the properties of the transistor and its underlying physical mechanisms.

Step by step, it gives the practicing or beginning engineer a working knowledge of quantitative transistor circuit design, based on a clear-cut understanding of the internal workings of a transistor device. It assures useful design accuracy with a prior knowledge of quantum mechanics.

The book stresses specific prototype circuit uses—not just general handbook coverage.

Safety Aspects of Nuclear Reactors

By C. Rogers McCullough. Published 1957 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 249 pages. Price $8.50.

That reactors and chemical plants can be operated without dangerous exposure is shown here. Part 1 of this study covers normal hazards, monitoring and decontaminating reactor components, with studies made of the dispersion of radioactivity by directing radiation, by liquids, by air currents and winds. Closely allied are the permissible concentrations of radio active material and the effects of irradiation that is the subject of Part 2.

Reactor accidents, their consequences and how they are minimized by design is discussed in Part 3. The monitoring of radiation in the atmosphere by winds and clouds, and an analysis of risks a disaster might produce are also covered.

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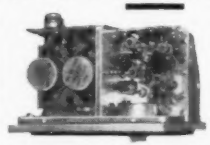

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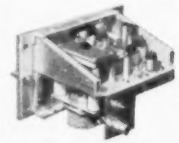

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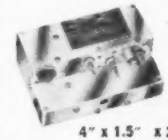

Model 1472

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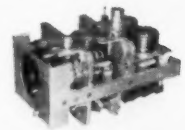

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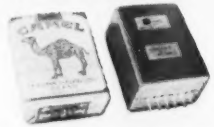

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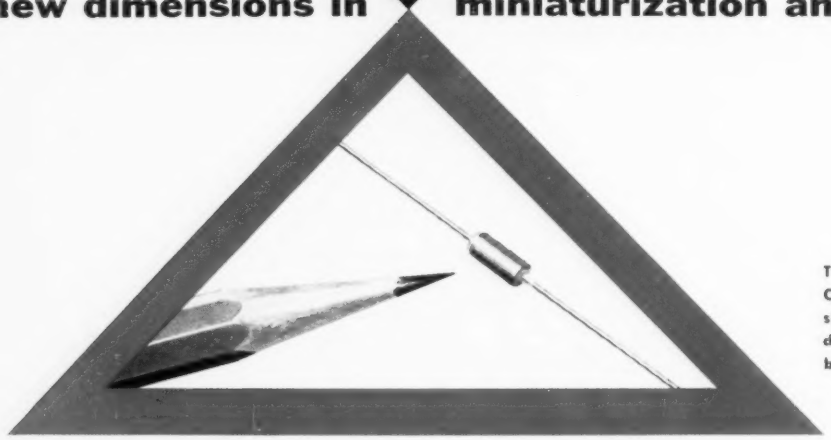

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Solid construction permits the Type 150D to withstand the severe shock and vibration encountered in missile and ballistic applications. Hermetic sealing makes it completely immune to humid atmospheric conditions.

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ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

Expanding International Electronic Sources

As a result of the recent successful launchings of "Sputnik" and "Muttnik," public attention in the U. S. was sharply focused on our lagging missile research and development programs and on our inadequate scientific educational facilities in the high schools and universities. Another element which became apparent was the fact that foreign scientists were producing much in the way of new creative work and the adequate means for transmitting this data to U. S. engineers was sorely lacking. In recent weeks there have been several announcements concerning this latter element.

Stanford Research Institute, for example, has issued a proposal for the establishment of a National Technical Information Center which can be considered as the counterpart of the Soviet All Union Institute of Scientific and Technical Information. An opportunistic publisher announces that he will start a new abstract service to keep American engineers informed by reviewing some 60 Russian journals. (For practicing electronic engineers we have found only about a half dozen journals to be of direct consequence.) Another established publisher is calling attention to the abstracts of Russian engineering articles appearing in his magazine. There have also been a variety of announcements from other sources which in one way or another plan to bring information on what the Russians are doing. In the very near future, therefore, American engineers can expect a veritable avalanche of Russian data. But . . . .

ELECTRONIC SOURCES

Engineers in other foreign countries, notably France, England, and W. Germany, and Japan, are also producing valuable creative engineering contributions. This is why in January 1956 ELECTRONIC INDUSTRIES created an abstract section known as International Electronic Sources. (p. 117 in this issue). Here each month summaries of 200 or more of the most important engineering developments reported in the leading technical journals throughout the world are presented. What is more, to assure the most current data in each issue, special arrangements have been made with foreign publishers to airmail their issues as they are published to our editorial offices here in Philadelphia. Thus the ELECTRONIC INDUSTRIES reader is kept abreast of what is happening not only in the USSR but throughout *the world!*

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In keeping with the thought of providing ELECTRONIC INDUSTRIES readers with the most up-to-the minute technical information throughout the world, our foreign editorial services are also being increased. We are now seeking manuscripts with important creative ideas directly from electronic engineers in foreign countries. As received, these manuscripts will be completely translated and presented as regular feature articles in the editorial section of future EI issues.

Thus, the combination of International Electronic Sources, our new foreign article photocopy service, and direct foreign feature presentations will, we feel, make it possible for the engineer reader of ELECTRONIC INDUSTRIES to be among the most completely informed in the world!

By TREVOR CLARK
Former Chairman, Microwave Relay Systems for Communication TR-14

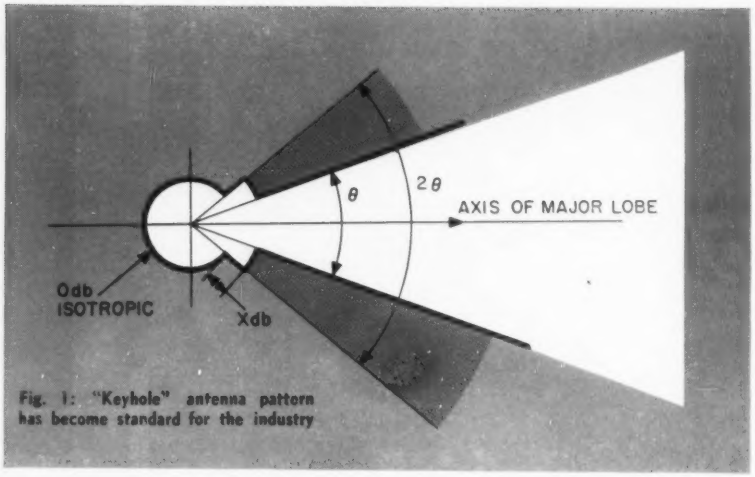


Fig. 1: "Keyhole" antenna pattern has become standard for the industry

Standardizing Microwave Communication Systems

A report on the progress achieved by the EIA Committee, Microwave Relay Systems for Communication—(TR-14), toward standardizing the various units of microwave systems and arriving at a glossary of terms to describe the microwave communication process.

Trevor Clark is Asst. to the Engineering Manager, Westinghouse Electric Corp., Air Arm Division, Friendship International Airport, Baltimore 3, Md.

MICROWAVE communication systems embrace most of the techniques of the communications art. They are used for remote control, telemetering, and the transmission of wideband intelligence, such as facsimile or television, as well as for telephone transmission. Among the users are not only common carrier (telephone and telegraph) companies but also many organizations and industries to whom communications are vital and who have previously depended upon the rental or the ownership of wire lines. Microwave communication systems utilize frequencies which range from the far infrared through the radio frequency spectrum, down to the lowest power frequencies, and even to direct current.

In planning the work of the EIA committee, Microwave Relay Systems for Communication—(TR-14), it was obvious that since many of the techniques of microwave communication are borrowed from other arts, the work should be divided so that specialists in the various fields could concentrate upon those terms, standards and methods of measurement which were within their ordinary practices. The principal committee (TR-14) was therefore divided into three-sub-committees and sub-subcommittees as shown in Fig. 6.

The total number of individuals involved in deliberations in committee has exceeded 200 and more than 80 companies have been represented in the formulation of the resulting documents. It is believed that through this means, the designers of microwave systems will, for the first time, have available detailed standards for the various portions of the systems and by reference to these standards it may be possible for buyers of communication systems to considerably simplify the specification of complete systems.

Because such varied yet detailed experience is available to the committees it is only natural that the standards developed should present viewpoints which might be somewhat new to the electronics industry. For instance, it was decided that the term "video" to describe broadband circuits would be improper be-

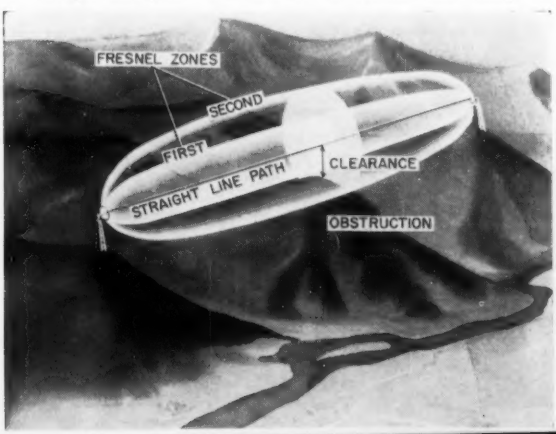
cause, in many cases, these circuits would not be carrying intelligence which would become visible.

Similarly, experience had shown that microwave carrier waves could cross-couple one microwave system to another resulting in interfering noise. Telephone men call this "cross talk." However from a semantic standpoint and through reference to the American Standards Association, IRG and other standardizing bodies it was decided that "cross talk" is essentially concerned with the coupling of voice-frequency energy (i.e., talk) from one telephone channel into another telephone channel. The term "cross coupling" more accurately describes the phenomena encountered in microwave.

Antennas

In the field of antennas and propagation there was even better reason to search for more exact terms. Atmospheric inhomogeneities cause refraction, reflection and other variations of microwave energy. It is necessary to consider the optical properties of microwaves in order to establish criteria for tower heights, antenna gain, dish size and other design criteria. A special task group was established to draw up standards for the microwave path and as a result of their work, a number of new concepts have been introduced. In order to avoid any ambiguity which might be due to the use of such terms as "optical path" or "effective path" it was decided that the set of definitions should begin from a mathematical fiction which would be called the "straight line path" defined as the axis of the Fresnel zone family. (See Figure 2). Although the actual propagation path is curved to a greater or lesser degree, it seems more convenient to use a mathematical fiction. Since this straight line path is invariant and depends only upon the spatial relationship of the final radiators of the antenna systems, the earth's surface does not enter into the definition. It was of course considered desirable that some normal transmission condition should be represented in drawing profiles, but since it has been found that a normal condition in one part of the world may be far from normal in another location, or at another time, the Task Group was compelled to decide that the surveyor should simply state what he considered to be normal and should give additional information in detail as to propagation conditions which might be encountered as daily or seasonal variations from this normal condition.

Fig. 2: Standards are based on the mathematical fiction, the "straight line path," the axis of the Fresnel zone family



"Transmission Path"

Another term the "microwave transmission path" (Figure 3) was defined to denote the actual path of the radio frequency energy. Reflectors may intentionally be interposed in such a path, and such a path is subject to effects of refraction and diffraction. The microwave transmission path may thus consist of one or more straight line paths and may include refractive or diffractive media.

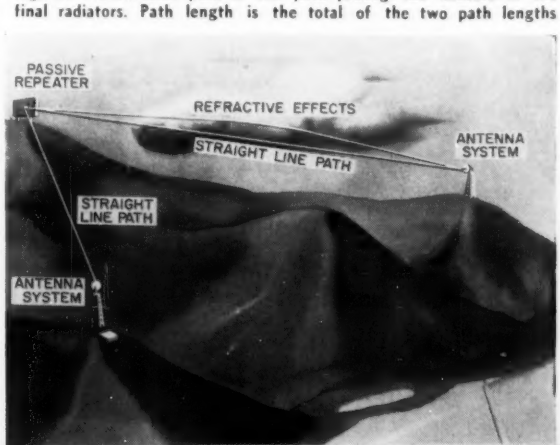
It has become quite common to talk of an unobstructed path as one which has no obstructions within a specified minimum clearance. An "obstruction" was therefore defined (Figs. 2 and 4) together with "primary obstruction" (one which exists within a minimum specified clearance) and "potential obstruction" (one which could, under certain conditions, become an obstruction). In order to account for the difference in frequency of transmitted waves, it was decided that "clearance" should be specified in terms of Fresnel zones and in order to account for changing atmospheric conditions it was considered essential that the "effective radius of the earth" used in computing the clearance should also be specified.

In the same way it was thought that one might often lose sight of the fact that the Fresnel zone is really cylindrical in section. It was thus decided that a term to describe path width should be included. This was defined as twice the minimum specified clearance. This makes path width a function of frequency and of the distance along the path from the final radiator of the antenna system.

In dealing further with the system it became apparent that the word "repeater" was being overworked and that a repeater might be anything from a small black box for repeating dial pulses to a large building containing several radio frequency equipments plus multiplexing equipment together with the necessary power controls and power supply equipment including engine generators and so forth and associated with towers having a multiplicity of antennas. A new term, "intermediate equipment" was coined to denote equipment which transmits to and/or receives from two other equipments.

By the use of diagrams such as Fig. 5, which might represent a typical system, the principal route between two principal terminals may be termed the "backbone" while any other routes might be termed "spurs." Thus a "terminal equipment" is an equip-

Fig. 3: Transmission path is the path joining the centers of the final radiators. Path length is the total of the two path lengths



Keyhole Microwave

(Continued)

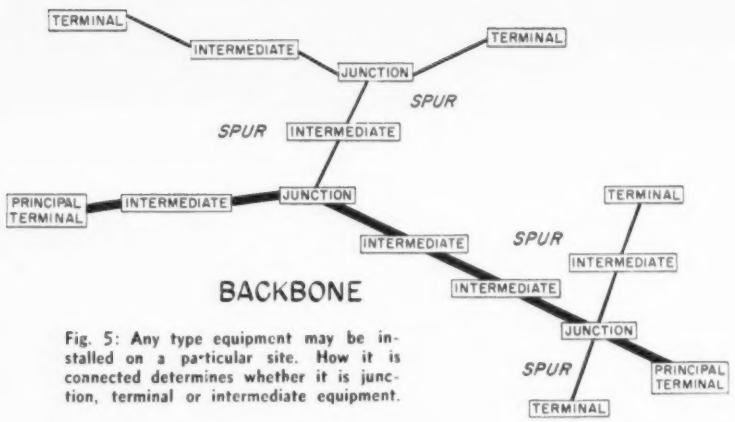


Fig. 5: Any type equipment may be installed on a particular site. How it is connected determines whether it is junction, terminal or intermediate equipment.

ment which transmits to and/or receives from only one other equipment, "junction equipment" is an equipment which transmits to and/or receives from three or more other equipments, and "spur" is a route between a junction equipment and a terminal equipment not on the backbone route. By reference to "equipments" it is possible to have terminal equipment installed with junction equipment at a site which might otherwise simply be called a repeater.

While these new terms are only just being issued as standards they have already begun to come into use in the preparation of proposals and bid requests. Through the use of other terms coined by the committee such as control center, alarm center, alarm and control center, auxiliary equipment, primary equipment, standby equipment and so forth it becomes possible to define the elements of a system with more exactness than in the past.

It has been noted above that the use of the term "video" was found to be inaccurate to describe the broad band of frequencies containing all the multiplex intelligence. This question had been considered by Group 65 on Communications of The American Standards Association. They had favored the use of the term "baseband" and had defined this term. Since it is this spectrum that is used to connect the multiplex equipment to the radio frequency equipment, the term is of interest to both committees TR-14.1 and TR-14.2. Both agreed that the ASA definition for baseband met the requirements of the standards in preparation and as a result both committees have begun building ancillary definitions and standards around this term.

Multiplexing

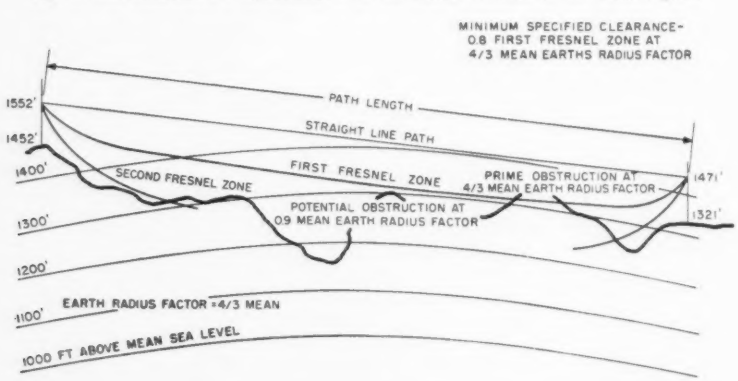
Microwave communication systems utilize two principal methods of multiplex, frequency division and time division. The two systems are not normally interconnected without the use of translation equipment and it is often found more economical to go to voice frequency whenever it is desired to interconnect one type of system with the other. The baseband for each method may be quite different. One of the principal objectives of the two committees was to determine that point in the connecting circuits at which the baseband characteristics should be measured. It was decided that this should be "the terminal point on the (radio or multiplex) equipment from which connection is normally made to the (multiplex or radio) equipment." (See Fig. 7.) Using this definition it is possible to specify impedances, levels, balance and other characteristics of the baseband circuit. This work is now going on jointly in TR-14.1 and TR-14.2.

A point of primary consideration in the installation and application of microwave communication systems is the degree of interference to be experienced from or to other systems in the immediate vicinity. Primary influencing factors are the power and spectrum of emission from the transmitter, the direction of radiation of the emitted energy, the directional characteristics of the antennas, and the selectivity and sensitivity of the receiver circuits.

Power output of the transmitter, and receiver characteristics such as selectivity and sensitivity have been defined in other services both as to standards, method of measurement and allowable deviations. It was felt, however, that the spectrum of emission of the transmitter and the antenna characeristics for the microwave systems had been inadequately defined in the past and many presently used definitions were subject to misinterpretation and ambiguity.

Up to the present time, the committee has been unable to find any saisfactory method for obtaining repeatable and significant measurements of the spectra of emission of microwave transmitters for communications. It must be remembered that the committee is dealing with such systems at frequencies above 890 MC where measuring instruments are relatively new and

Fig. 4: The PROFILE is a representation of the Earth's contour in the vertical plane



where the power output may range from megawatts peak to milliwatts average each service providing a satisfactory communication link. The Atlantic City ITU Convention (1947) sets a method for specifying the bandwidth of emission of radio transmitters as follows: "The specified band shall contain those frequencies upon which a total of 99% of the total power appears, extended to include any discrete frequency upon which the power is at least 0.25% of the total radiated power." Licenses for operation in accordance with this Convention are presently issued by the FCC and other regulatory bodies for systems in this service. To date however the committee has been unable to find any commercially available test equipment whose manufacturers will guarantee to be able to measure the emission of microwave communications transmitters to the accuracy required by the Convention. The EIA committees have therefore simply noted those terms which require definition in the future so that satisfactory standards may subsequently be established when the state of the art permits.

As the art of microwaves has advanced, it has become apparent that the usefulness of this service was so great that it would soon be necessary to practice the same measures of spectrum conservation as have previously been applied in the lower frequency services. With the wide ranges of power available, and the different systems of multiplexing, cases of interference have appeared. Many of these cases occurred in situations where they were least expected. In many other cases where interference was expected, it never developed.

There was not very much background information on means for preventing inter-system interference through the use of directional antennas alone. Regulatory bodies had not given great credence in the past to the possibility that use of directional antennas would permit geographical crowding of radio systems. The committees decided that it should be possible to specify the maximum field strengths which should be expected in various directions around the transmitting antenna system. It was decided that field strength should be standardized relative to the field strength which would be obtained from an isotropic radiator.

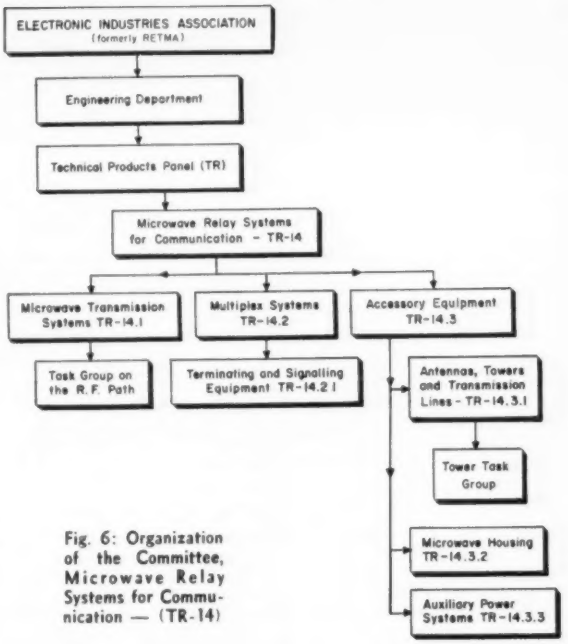

ELECTRONIC INDUSTRIES ASSOCIATION
(formerly RETMA)
Engineering Department
Technical Products Panel (TR)
Microwave Relay Systems for Communication - TR-14
Microwave Transmission Systems TR-14.1
Multiplex Systems TR-14.2
Accessory Equipment TR-14.3
Task Group on the R.F. Path
Terminating and Signalling Equipment TR-14.2.1
Antennas, Towers and Transmission Lines - TR-14.3.1
Tower Task Group
Microwave Housing TR-14.3.2
Auxiliary Power Systems TR-14.3.3

Fig. 6: Organization of the Committee, Microwave Relay Systems for Communication — (TR-14)

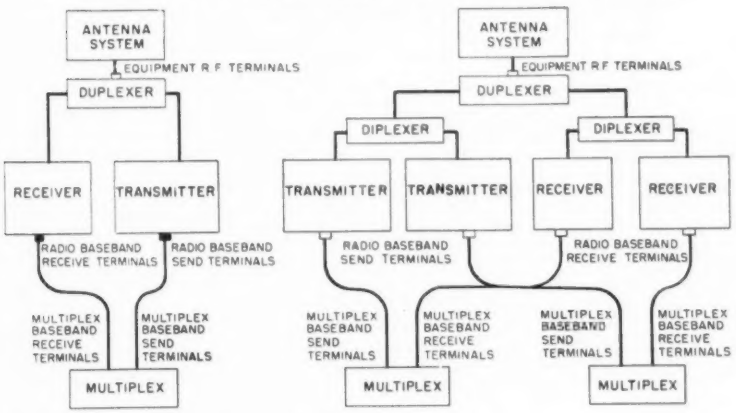
This encourages system designers to make use of those antenna systems which will best suppress spurious lobes.

Following a joint industry-Government conference called by the FCC during March and April 1955, members of the RETMA (EIA) Microwave Section realized the need for coordinating their views with the appropriate TR-14 engineering committees.

Subsequently, members of the Microwave Section adopted a resolution on June 14, 1955 proposing the establishment of an Ad Hoc Committee "for the purpose of assisting the Federal Communications Commission in formulation of permanent microwave rule making."

On September 13, 1955 the committee, consisting of two representatives of each of 12 companies, was formed. The Ad Hoc Committee then was broken into two sub-committees representing the Commercial and Engineering groups, respectively.

Fig. 7: Standards do not distinguish equipments but set methods for measurement



Scope

The scope of the Ad Hoc Committee was as follows: "In the interest of furthering the formation of permanent microwave rules, it is the object of this committee to summarize areas of present understanding and establish new areas of standardization among manufacturers thus enabling RETMA to assist the commission and industry users in the promotion of the orderly and progressive development of the Microwave Communications art."

Keyhole Microwave *(Concluded)*

The work of the Ad Hoc Committee was consummated in January of 1957 when its proposed Part 22 was submitted to the FCC. The Ad Hoc Committee was disbanded at that time.

"Keyhole" Pattern

The antenna system concept which finally has been standardized by TR-14.1 has become known as the "keyhole" because of the shape of the radiation pattern. (Fig. 1.) A total horizontal angle theta in the direction of the major lobe may have the field strength desired. In an angle two theta wide, the field strength should not be more than X db above the zero db (isotropic) level. At all other angles the field strength should not be above that which would be produced by the same transmitter power into an isotropic radiator. Both theta and X are dependent upon frequency and values have been chosen which are being met at the present time.

The purchaser of a microwave system may not be interested in the technical details by means of which the transmission of the communication is accomplished. It may be that his interest is that when intelligence is fed into the system at one point, that same intelligence can be derived at another point in the system. Subcommittee TR-14.2 began its work with this user in mind and with the thought that the most common channel of communication was the telephone channel. It was recognized that telephone channels might be combined into wide band channels or that they might be sub-multiplexed into a greater number of narrow band channels. Nevertheless, as a common denominator the telephone channel permitted all manufacturers and users to begin to speak in the same language about the performance of the system.

TR-141 contains standards for channel loading which permit the determination of characteristics of the complete system in the laboratory or in the field. The committee approached the problem of Transmission Gain Stability under environmental conditions and wrote a standard for this characteristic. TR-141 also sets up standards for signal-to-noise ratio in the telephone channel together with a method of measurement.[1]

One of the newer sub-subcommittees is TR-14.2.1 which has already developed one standard on Terminating Equipment (SP-533) and is proceeding to study standards for telemetry, control and other submultiplex functions. With increasing use of record transmission and data processing, the work of this group has taken on added significance.

The sub-subcommittee on Microwave Housing Facilities TR-14.3.2 established many criteria which were generally agreed to be necessary to properly protect electronic equipment in the microwave service. Their standard, TR-142, references many standards from the building industries which will assist the electronic engineer in determining what type of housing and construction is best suited for microwave systems. This sub-subcommittee was composed almost entirely of the representatives of those firms which have specialized in the design and construction of housing used in microwave communication systems.

Sub-subcommittee TR-14.3.1 has produced standard RS-158 which enables the system designer to determine mechanical considerations to be applied to the design and installation of transmission lines in microwave relay applications. Such things as bonding, pressure tightness and protection against ice and other damage are called out. TR-14.3.1 has also completed standards on Towers (RS-194) and on Mechanical Characteristics for Microwave Antennas and Passive Reflectors (RS-195). This group has also assumed the responsibility for revising and maintaining standard TR-116 on Radio Towers. A Tower Task Group is presently developing standards for the very high towers now coming into use.

Sub-subcommittee TR-14.3.3 produced standard RS-173 on Emergency Standby Power Generators and Accessories for Microwave Systems. Here again liberal references are made to the standards of related industries where a considerable amount of experience has been accumulated. The standards themselves were produced by microwave system designers working closely with committee members representing the manufacturers of engine generators. The standards contain much material in approved form which previously had been a matter of conjecture to the electronics designer. This group is now continuing work on Voltage Regulators and Standards for Primary Power Systems.

TABLE I: The following EIA Standards on Microwave Relay Systems for Communication are available from the EIA Engineering Department, 11 W. 42nd St., N. Y., N. Y.

TR-141—Microwave Relay Systems for Communications—Standards for the Telephone Channel. (TR-14.2)

TR-142—Standards for Microwave Housing Facilities. (TR-14.3.2)

RS-158—Mechanical Considerations for Transmission Lines in Microwave Relay Applications. (TR-14.3.1)

RS-173—Emergency Stand-by Power Generators and Accessories for Microwave Systems. (TR-14.3.3)

RS-194—Microwave Towers. (TR-14.3.1)

RS-195—Mechanical Characteristics for Microwave Antennas and Passive Reflectors. (TR-14.3.1

RS-203—Microwave Transmission Systems. (TR-14.1)

The following standards are presently in the final stages of preparation.

SP-533—Terminating and Signalling Equipment for Microwave Communications Systems—Part I—Telephone Equipment. (TR-14.2.1)

The following standards are in preparation—

Standards for the Baseband Channel—TR-14.2 jointly with TR-14.1

Terminating and Signalling Equipment for Microwave Communications Systems, Part II Telegraph and Data Transmission TR-14.2.1

Maintenance of TR-116—Standards for Radio Towers—TR-14.3.1 (Task Group on Towers.)

Standards for Voltage Regulators and Primary Power Systems.—TR-14.3.3

References

[1] See also H. C. Franke, "Noise Measurements on Telephone Circuits." **Tele-Tech and Electronic Industries**, Vol. 14, pp. 85-87, March 1955.

Integrating Voltage Sources

DC amplifiers with capacitive feedback as voltage source integrators introduce errors not present when a current source is used. Operating conditions and errors produced are discussed.

By GEORGE F. SCHRADER
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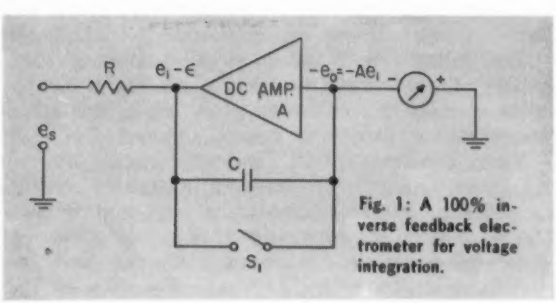

Fig. 1: A 100% inverse feedback electrometer for voltage integration.

IT is frequently necessary and desirable in computer, control, or measuring devices to use a 100% inverse feedback dc amplifier to integrate a voltage whose source is connected to ground. This article indicates the errors produced in this type of system due to the source impedance and other factors not found when a current source is used. Such a system is shown in Fig. 1.

The symbols used below are as follows:

A = dc amplifier gain.

e_s = instantaneous value of source voltage.

E_s = average source voltage over one period of integration.

e_i = instantaneous voltage at the input of dc amplifier relative to input voltage, unit zeroed.

ϵ = potential difference between input to amplifier and ground, unit zeroed. There is always some small error because it is impossible to zero the amplifier exactly, and because the zero point may also drift. This is given the polarity as measured on the meter.

e_c = voltage on capacitor.

R = internal resistance of source, plus any added series resistance.

C = value of feedback capacitor.

e_o = voltage at output of amplifier, measured with the meter connected as shown (it is equal to Ae_i although in opposite polarity to voltage, measured with respect to ground. Polarity of amplifier output is opposite input polarity).

E_o = output voltage at the end of integration period. Usually the capacitor is then discharged and a new period of integration is started.

T = time for one integration period. It is presumed that S_1 is normally closed and is opened at beginning of each integration period, and left open for the period. The unit is usually recycled automatically by having S_1 close momentarily at some preset value of output voltage so that the unit returns to zero and continues to integrate.

t = time from beginning of cycle.

i = input current from source. It is presumed that the dc amplifier uses no input current.

(*Continued on page* 110)

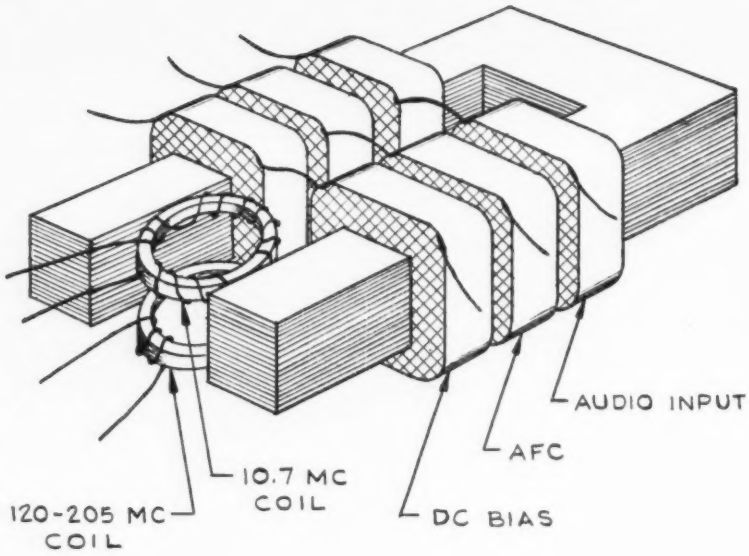

Fig. 1: This experimental saturable reactor was designed for 120-205 MC. At 150 KC deviation, distortion was reduced from .5% to .05% with 20 db feedback.

By A. B. PRZEDPELSKI
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7627 Lake Street
River Forest, Ill.

Simple Circuit Stabilizes

A. B. Przedpelski

FERRITE saturable core FM modulators have two serious drawbacks. Temperature changes cause frequency instability; and μ/H non-linearities and hysteresis effects cause distortion. The circuit described here was developed to eliminate these drawbacks in a modulator for a variable frequency FM oscillator.

The frequency drift with temperature of oscillators with ferrite cores takes place as the result of the change of

$$\mu_{ac}\left(\mu_{ac} = \frac{dB}{dH}\right),$$

"incremental" permeability for low ac signals with temperature. This effect is rather difficult to compensate since the temperature coefficient of the ferrite may vary with temperature and also varies with flux density. Most ferrite materials have a positive coefficient at very low flux densities. The coefficient goes through zero and becomes negative as flux density is increased.

For distortionless modulation, frequency of the oscillator has to vary linearly with the audio current (or voltage). Since H is proportional to current:

$$f = aH + b$$

$$\text{or } \mu_{ac} = \frac{C}{(aH + b)^2}$$

By integrating μ_{ac}, which is the shape of the B – H curve, we can obtain the curve itself:

$$\mu_{ac} = \frac{dB}{dH} = \frac{C}{(aH + b)^2}$$

$$\text{or } B = C\int \frac{dH}{(aH + b)^2}$$

$$= \frac{-C}{a\,(aH + b)} + C'$$

Using the limit B = O, H = O, we obtain:

$$B = C''\left(-\frac{1}{H + 1} + 1\right) = C''\left(\frac{H}{H + 1}\right)$$

$$\text{or } \mu = C''\left(\frac{1}{H + 1}\right)$$

This curve is approached fairly closely in actual ferrite cores for most application.

For critical low distortion circuits, however, some means of reducing distortion is necessary. Simple wave shaping is not satisfactory since the curve varies with dc bias, temperature, and age.

Both frequency drift and distortion can be minimized in single frequency FM modulated circuits by detecting the modulated signal and feeding both the ac and the dc component back into the reactor. This system can also be applied to a decade or other system, synthesizing the necessary frequency by the

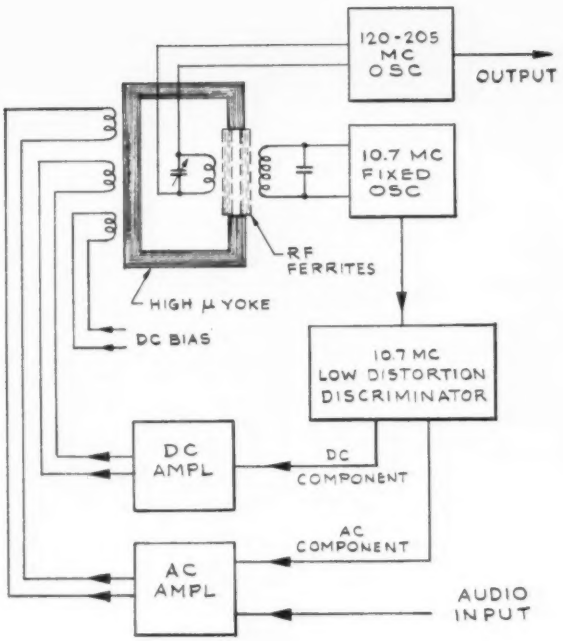

Fig. 2: This block diagram shows the technique used to reduce distortion and drift in a variable-frequency FM modulator.

*Single-frequency FM modulators can be stabilized quite simply by detecting the modulated signal and feeding it back to the reactor. Here is a circuit which achieves the same simplicity in stabilizing a ferrite FM modulator over a range of frequencies.**

Ferrite FM Modulator

means of crystal oscillators. In a variable frequency oscillator this system becomes impractical, since a practically complete FM receiver has to be employed, perfectly tracking with the oscillator circuit.

In the particular case where our experiments were performed, a low distortion FM modulated oscillator, covering the r-f range of 120—205 MC, was needed. A ferrite core of suitable material was used to provide the circuit inductance and a variable capacitor was used to cover the necessary frequency range. Another coil was wound using the same type and size core as the variable oscillator coil, but tuned to 10.7 MC with a suitable capacitor. (The number of turns for both coils does not have to be exactly the same, but the winding length should be comparable).

The 10.7 MC tuned circuit is used in a fixed oscillator, the voltage of which is sampled and fed into a low distortion, high stability 10.7 MC discriminator. The two coils are placed symmetrically (to provide identical flux distribution) in a high μ laminated yoke. The yoke is used to provide more flexibility in arrangements of modulating, feedback, and bias windings and to eliminate interaction between r-f and control windings. The dc output of the discriminator is fed through a dc amplifier to one winding on the yoke. The polarity is such that the frequency change caused by this signal opposes the original frequency change which caused the dc output from the discriminator to appear. The ac component is fed into an audio amplifier 180° out of phase with the incoming audio signal, thus providing negative audio feedback.

Since the cores are identical and the flux density in both is the same, the dc and ac negative feedback will decrease frequency drift caused by ferrite temperature effects, also decreasing distortion of the modulated signal. The degree of reduction depends on the quality of the discriminator demodulator as well as the amount of feedback. Frequency response is also improved by negative feedback.

In a circuit similar to that shown in Fig. 1, at 150 KC deviation, a reduction of distortion from 0.5% to 0.05% resulted with approximately 20 db of feedback.

This circuit is rather flexible, and different frequencies can be accommodated. The two coils can be separated with parts of the yoke to prevent interaction, as long as the flux densities remain the same.

* Patent applied for.

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A Transistor Tester for the Experimental Lab

The electronics laboratory often finds use for simple "kit" or "home-brewed" test equipment. Here is a carefully designed transistor tester which will prove invaluable for checking transistor parameters. The author has designed a self-contained instrument which is simple and economical to build.

By ROY A. HEMPEL

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EVERYONE in the electronic field is aware of the tremendous increase in transistorized products in the past few years. Engineers working in this new field know the value of being able to check transistors, but many cannot afford the more elaborate and expensive transistor testers. Often, valuable time is spent on an overly simplified transistor checker, only to find that an auxiliary oscillator, voltmeter, etc., is still needed.

This transistor tester has proved an invaluable aid for transistor testing and transistor circuit development. It has the advantage over more simple testers of being able to check transistors from 1 KC to 1 MC. No external test apparatus is needed. The instrument is completely self-contained, with a built-in oscillator and meter. Five standard flashlight cells are used, and these last for practically their entire shelf-life.

The instrument described here is complete and will not tie up external test equipment. It can be assembled in a few evenings of spare time. It will check both PNP and NPN transistors for ac beta from 10 to 1000, I_{co} from 0 μa to 1 ma, and I_c from 0 ma to more than 6 ma. External connections are available for testing diode reverse current flow. Separate terminals are also available for testing filters, amplifiers, and other circuitry.

Circuit Description

A block diagram of the circuit is given in Fig. 3. The oscillator operates into an emitter follower. The emitter follower (grounded collector) has a voltage gain less than unity and some current and power gain. It is used here to prevent frequency shifts from loading the oscillator directly by the transistor under test.

The output of the emitter follower is available through a 2.5 K pot to both external terminals and to the base of the transistor under test.

It is important to note that when a transistor is being tested the oscillator output should not have an external load connected.

The collector output of the transistor under test goes to an isolating emitter follower stage and then to a diode rectifier circuit. Another emitter follower is used to convert the diode rectifier output to the lower impedance level required by the 0-100 μa meter.

The I_{co}, beta, and I_c measurements are read directly from the meter. I_{co} is read in microamperes, beta direct from the meter scale, and I_c in milliamperes with full scale being 1 ma.

Two basic types of oscillator circuits are used (Fig. 5). For low frequencies of 1 KC and 10 KC, a grounded base configuration is used. For frequencies of 25 KC, 50 KC, 75 KC, 100 KC, 200 KC, 500 KC, and 1 MC, a grounded emitter circuit was found best.

The oscillator switch is a six gang (1 pole per gang) 11 position switch. The 2N114 and 2N78 transistor

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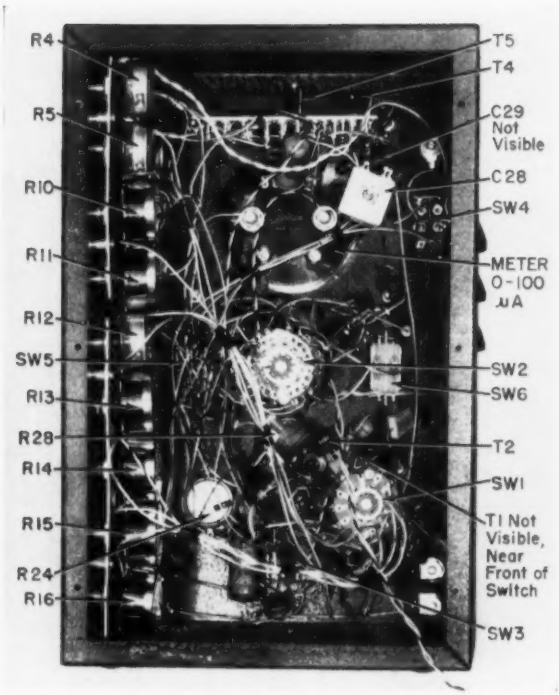


Fig. 1: Location of components; most small parts mount on switches.

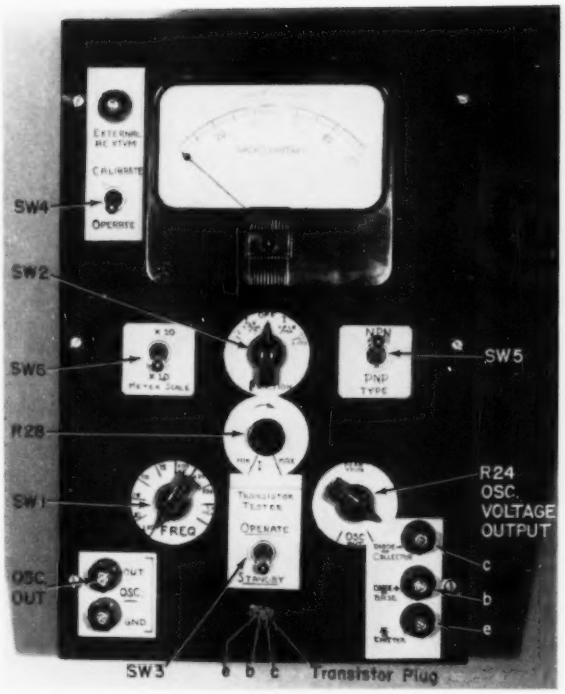


Fig. 2: Face of tester; external meter is needed only for adjustment.

sockets are mounted on the switch, as are most of the other components. To make parts-mounting easier, the six switch wafers were moved closer together and a seventh wafer was added to the switch. Many of the components were tied to the seventh wafer terminals. All oscillator wiring was kept as short as possible.

Basic Circuits

Figures 6 and 7 show the basic circuitry employed for PNP and NPN transistors to measure ac small signal current amplification more commonly referred to

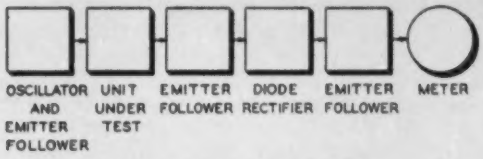


Fig. 3: Block diagram of the transistor tester.

as ac beta, and collector leakage current referred to as I_{co}.[1, 2]

Meter Circuit

The meter circuit is shown in Fig. 8. No amplification is required with the sensitive 0-100 μa meter used. Type 2N135 transistors are used, although such types as 2N113 and 2N114 may also be used.

The oscillator choke coils L2 through L9 should preferably be ferrite core chokes such as Grayburne ferri-chokes.

These have a higher Q than normal air core chokes and permit easier and more stable oscillation.

The chokes L10 and L11 are ferrite core made by Grayburne and are necessary only to prevent excessive signal attenuation at 500 KC and 1 MC.

Three pots—R33 (Hi adjust), R38 (Medium adjust), and R34 (Lo adjust)—are used to adjust the linearity of the meter over its full range. These pots will need trimming whenever the transistors are changed, or if the battery voltage drops under 5.9 volts (normal about 6.3 volts).

Frequency-amplitude-adjust pots R4, R5, and R10 through R16 control the 1 KC to 1 MC amplitudes over a narrow range.

These pots are also mounted vertically on a bracket behind the right side of the tester. Pot R4 (1 KC) is at the top.

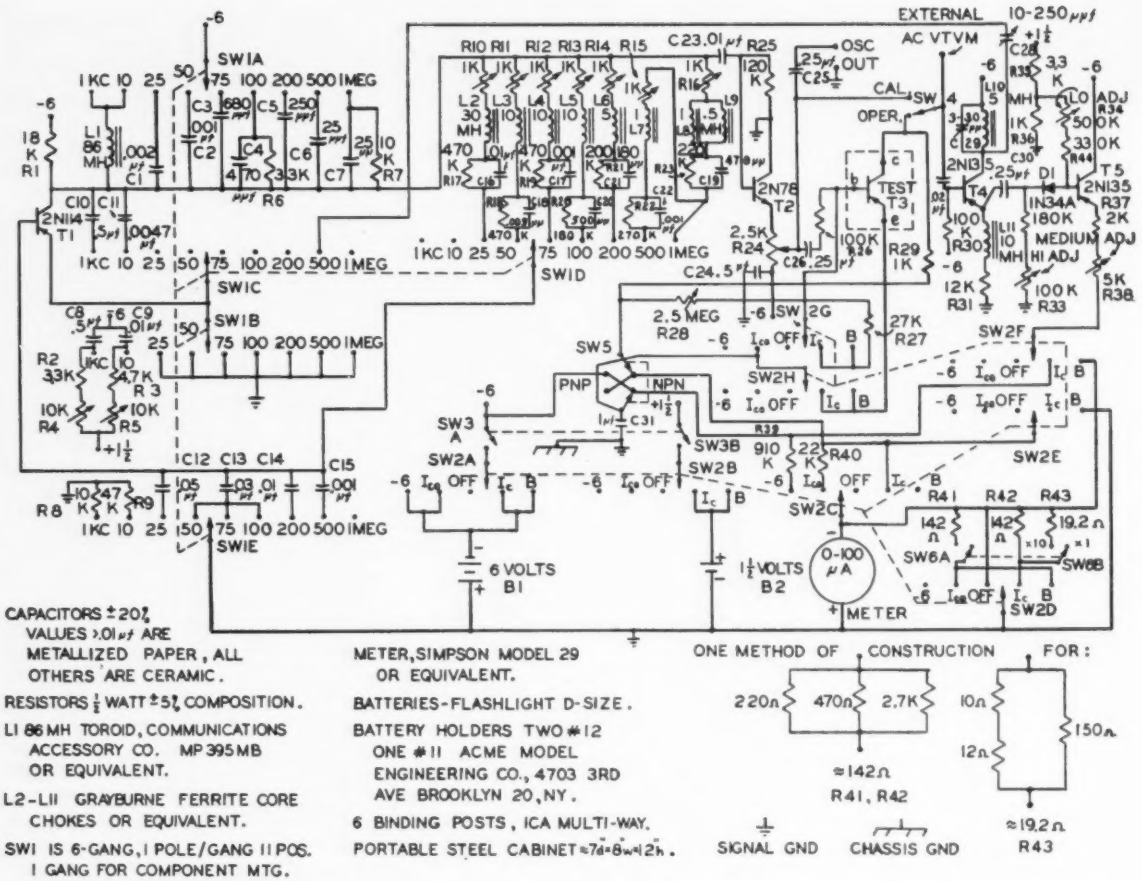
Adjustment

After construction, the first step is to check the oscillator output. Set the meter scale switch on x10 position, the function switch on current position, and the power switch on operate.

Connect a wide band oscilloscope to the 2N114 transistor (T1) collector.

Adjust each of the frequency amplitude pots R4, R5, and R10 through R16 to minimum resistance. Check each of the nine frequencies. The output voltage should be 3 to 4.5 volts peak to peak.

If there is no oscillation, if the amplitude for some frequencies is way off, or if the sine wave output is badly distorted, double check all circuit wiring and components for errors. If the amplitude is only slightly out of tolerance let it go for the time being and move on to the next check.



CAPACITORS ±20% VALUES >.01 μf ARE METALLIZED PAPER, ALL OTHERS ARE CERAMIC.

RESISTORS ½ WATT ±5% COMPOSITION.

L1 86 MH TOROID, COMMUNICATIONS ACCESSORY CO. MP 395 MB OR EQUIVALENT.

L2-L11 GRAYBURNE FERRITE CORE CHOKES OR EQUIVALENT.

SW1 IS 6-GANG, 1 POLE/GANG 11 POS. 1 GANG FOR COMPONENT MTG.

SW2 IS 4-GANG, 2 POLE/GANG 6 POS.

METER, SIMPSON MODEL 29 OR EQUIVALENT.

BATTERIES - FLASHLIGHT D-SIZE.

BATTERY HOLDERS TWO #12 ONE #11 ACME MODEL ENGINEERING CO., 4703 3RD AVE BROOKLYN 20, NY.

6 BINDING POSTS, ICA MULTI-WAY.

PORTABLE STEEL CABINET ≈7"×8"×12".

Fig. 4: Complete schematic of the transistor tester. The lead labeled "External AC VTVM" is needed only for calibration of the instrument meter.

Transistor Tester *(Continued)*

Second Step

For the next adjustment, place the scope on the 2N78 transistor (T2) emitter, or on the external oscillator output terminals. The oscillator pot R24 should be turned to the extreme clockwise position for maximum output.

The output amplitude should be approximately the same for each frequency as it was when checking on T1 collector, with the exception of 500 KC and 1 MC which may be down as much as 10 per cent. If the output is down more than 10 per cent at frequencies of 100 KC and up, it may be necessary to select another 2N78 with better high frequency response.

Oscillator Check

For the third step, the scope should be connected to the oscillator output terminals with the frequency set initially on 1 KC.

Calibrate the scope for 2.82 volts peak-to-peak. Adjust R4 until the 1 KC output equals 2.82 volts peak-to-peak. If an RMS voltmeter[3] is available, it may be connected across the oscillator output terminals and R4 adjusted to give 1 volt RMS output.

Switch to 10 KC and adjust R5 for 2.82 volts peak-to-peak, and repeat for each frequency, in each case adjusting the correct pot. When finished, run through all frequencies once more, making minor adjustments where necessary, until the output from 1 KC through 1 MC is a constant 2.82 volts peak-to-peak or 1 volt RMS. Mark the final oscillator output knob setting, 1 volt. This finishes the adjustment of the oscillator section of the tester.

Meter Shunts

The fourth step is to check the meter shunts for accuracy. If an accurate 0-1 ma dc meter is available place it in series with the tester meter. Start with the current control R28 in mid-position. Turn the meter scale switch to xl position.

Insert a PNP transistor into the socket making sure first that the TYPE switch is on PNP. Adjust the current control R28 until both meters read 1 ma full scale. If the tester meter does not read full scale modify the shunt resistor R42 until the meters read identically.

Meter Linearity

The fifth step is to adjust the meter linearity pots, R33, R34, and R38. First remove the external PNP

transistor used in the fourth adjustment step. Attach a high frequency ac vacuum tube voltmeter[3] to the upper left binding post on the front panel.

If the scope is calibrated every .4 volts from 0 to 2.82 volts it may also be used, although for this test the ac VTVM proved handier.

Set the meter scale switch on xl, the frequency on 1 KC, and the function switch on beta. Set the oscillator output pot on the 1 volt mark. The external ac meter should read 1 volt RMS. The tester meter should be somewhere near full scale.

Adjust R33 Hi-adjust pot until the tester meter reads full scale.

Readjust the oscillator output to give .1 volt on the external meter. Adjust R34 Lo-adjust pot until the tester meter reads 1/10 full scale, i.e. the same as the external meter. Repeat with oscillator output pot set to give .5 volt on the external meter. Now adjust R38 Medium adjust pot until tester meter reads ½ full scale. Repeat checks at both ends of scale. It may be necessary to repeat this adjustment process several times until the operator is satisfied that his meter checks as closely as possible with the external AC meter.

Final Adjustment

The sixth and final adjustment step is to set the meter scale on xl and adjust the oscillator output for 1 volt at 1 KC. Switch from 1 KC in steps through 200 KC. The meter should read approximately full scale for each of the frequencies. A slight readjustment of the oscillator amplitude pots R4, R5, R10 through R16 may be necessary. Skip from 200 KC to 1 MC and adjust trimmer C29 to bring 1 MC output to full scale. Switch back to 500 KC and adjust trimmer C28 to bring 500 KC output to full scale. Switch through all frequencies once more for a final adjustment. The tester is now ready to check transistors.

General Operation

Always observe the following procedure when checking transistors. If there is any doubt as to whether a transistor is shorted, throw the meter scale switch on x10. This protects the meter. Always be sure that the TYPE switch is thrown to the type of transistor being tested. Be sure the center switch is on STANDBY whenever a transistor is inserted or removed from its socket. Start with the current pot in mid-position to prevent excessive current from flowing through some transistors. Be sure that the oscillator output pot is set on 1 volt RMS out. And finally, don't insert the transistor backwards in its socket or across the terminals.

If these simple rules are followed (and they tend to become automatic after checking any number of transistors) both the tester and the transistors being checked will have a long life.

References

1. Hamlin, W. O.: "Transistor Testing and Handling," *Radio-Electronics*, February 1957.

2. Zarr, R.: "Transistor Tester," *Radio & Television News*, Sept. 1956.

3. Schmidt, A. H.: "Improving V.T.V.M. Linearity," *Radio & Television News*, May 1957.

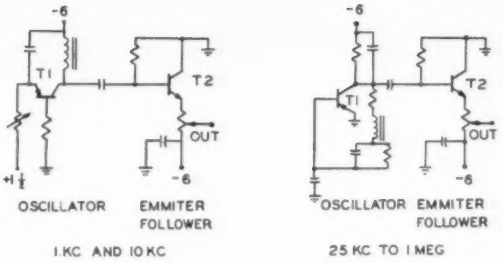


Fig. 5: These two basic oscillators are used.

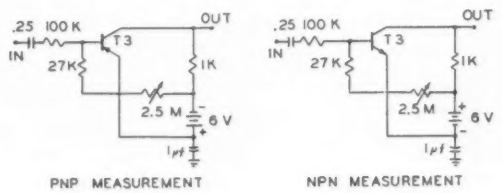


Fig. 6: Basic Beta measurement circuits.

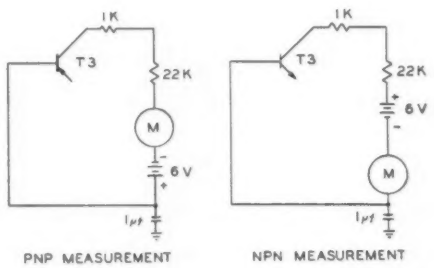
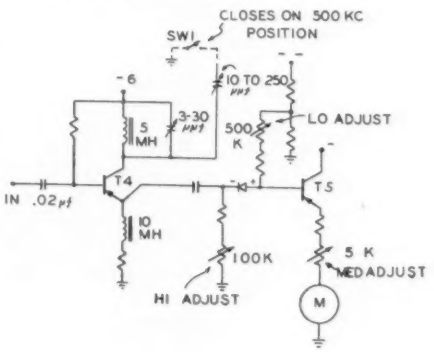


Fig. 7: I_{co} measurement is based on these circuits.

Fig. 8: Circuits for the self-contained meter.



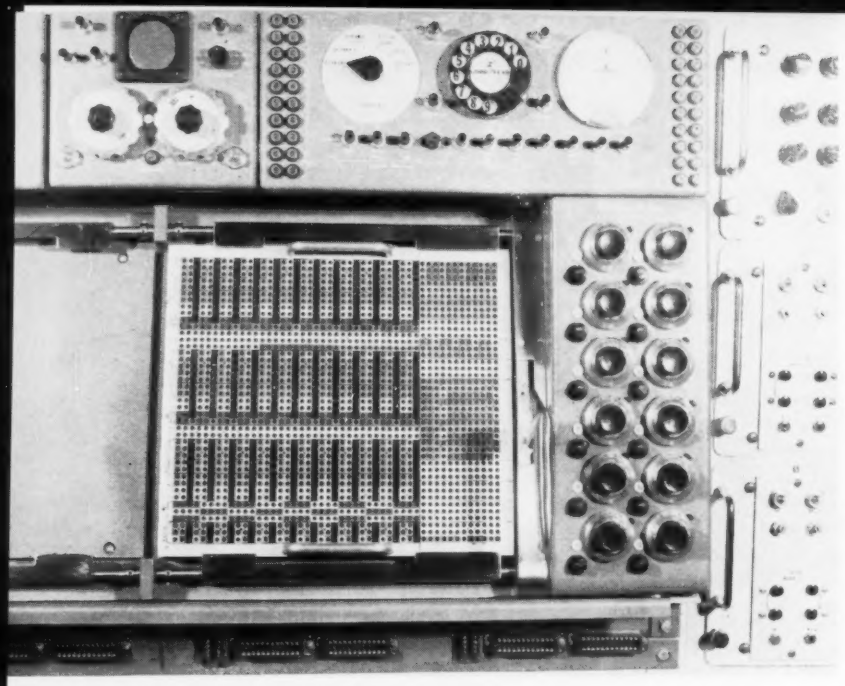


Fig. 1: Problem Board and control panels of the GEDA A14 Problem Analyzer System.

Checking on Computers

A New Approach to Verification

With analog computers becoming larger and more complex, point-to-point checking of components is prohibitively time consuming. A computer whose unique problem analyzer reduces verification time to 40 minutes is described.

By WILLIAM C. MEILANDER

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Computer Engineering Dept.
Goodyear Aircraft Corp., Akron 15, Ohio

DURING the past decade, the electronic differential analyzer has become an effective research and development tool. Present techniques allow the computer user to translate nearly every conceivable physical[1] system into computer wiring diagrams.

The analog computer ideally is a super slide rule, for while it is easily capable of arithmetic operations, its outstanding ability to handle integrodifferential operations is its most salient feature. The conventional slide rule has been accepted as a reliable device, but the differential analyzer has not been so universally received. In fact, one of the more difficult problems associated with differential analyzers is determining whether they are solving the desired mathematical relations.

The obvious technique of point-to-point verification of the wiring diagram is far too time consuming to be practical for most problems; therefore, several

necessarily cumbersome methods have been developed to ascertain when the computer is correctly wired for a given problem.

Reliability Problem

The problem, then, is: how can the reliability of the electronic differential analyzer be made more comparable to that of its simpler predecessor?

In the early days of analog computer use, the problems were comparatively simple. The small number of amplifiers and computing elements employed for a given problem did not require an elaborate method for determining whether the correct hookup was made on the problem board or whether the elements of the computer were operating correctly.

Today, analog computers are becoming larger and more complex. The number of elements used for a given problem may exceed several hundred. Checking the computer to determine that the components are operating satisfactorily and, more important, that the problem is correctly wired has become a bothersome task.

The individual scales of a slide rule are checked by matching the indexes correctly for a particular problem. The result is accepted without question. The differential analyzer can be checked in a similar manner by verifying each computing operation, including scale, and comparing the hookup with the desired wiring diagram or directly with the desired mathematical relations.

The GEDA[2] A14 computer readily copes with difficulties of problem analysis by using a system that readily provides a complete printed record of the wiring system and its individual components. The problem-board hookup can be verified exactly; i.e., each amplifier and each computing element can be checked to determine that it is correctly connected to the next computing element in the wiring. The A14 problem-analyzer system also indicates whether the element under test is hooked up as a summer or as an integrator and determines the over-all gain setting of the element in question.

In Fig. 2, the over-all gain, K, involves all the computing circuits associated with the amplifier for a given problem. The computer network, as it is hooked up with its coefficient potentiometer, its input resistor, and its feedback circuits, must provide a gain setting to fit the requirements of the problem.

The A14 problem-analyzer system easily determines the correct gain setting by the method shown in Fig. 3. A single-pole double throw relay is located at the output of each amplifier and at each of the other computing elements. This relay will switch the output of the amplifier to an equivalent test-output voltage which, in turn, is applied as a substitute for the output of amplifier 1.

When the output-monitor switch is stepped to position 2, the output depends on the feedback and the input circuits of amplifier 2, thus providing a complete check on the over-all gain of amplifier 2. Similarly, when the monitor switch is stepped to position 6, the output of amplifier 6 represents the over-all gain produced by that part of the system from the equivalent output of amplifier 1 to the output of amplifier 6, including the effects of the feedback resistor, the input resistor, and the coefficient potentiometer. An integrator or any of the nonlinear elements of the A14 computer may be checked by using the A14 problem-analyzer system.

By checking the network feedback, input resistors, and coefficient potentiometers in this manner, the amplifier performance also is verified. A comparison of results obtained by the problem analyzer with a block diagram of the desired wiring quickly reveals whether the problem is correctly wired and pinpoints the location of any errors.

Operating Checkout Procedure

In actual operation the checkout procedure is somewhat different. The output monitor switch automatically scans all outputs and records the output of each element on an automatic printer, providing a record in digital form for comparison with the wiring diagram. For a typical system involving 100 amplifiers and 20 nonlinear components, it would be possible to check completely not only the wiring but also the machine components and the gain setting of each of the computing elements in about 40 min. of computer time.

The analyzing operation is not dependent on arithmetic. The operator does nothing but examine the printed results. All gain settings are recorded in their exact values by the printer, except those

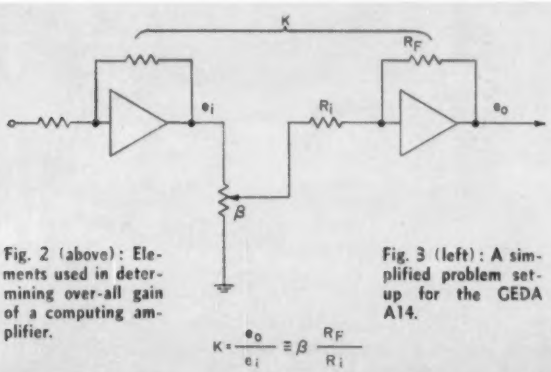


Fig. 2 (above): Elements used in determining over-all gain of a computing amplifier.

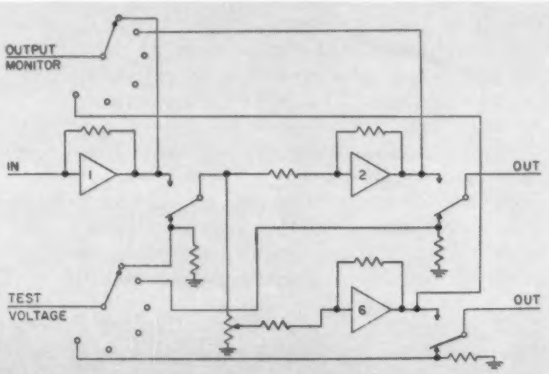


Fig. 3 (left): A simplified problem setup for the GEDA A14.

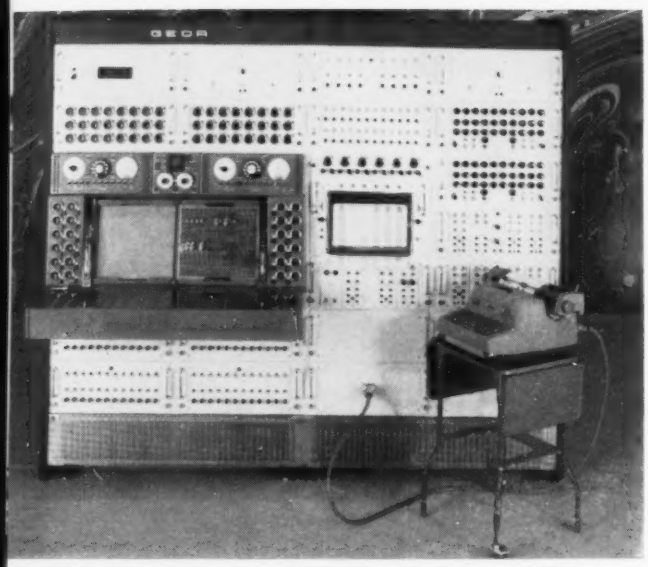


Fig. 4: Typical small GEDA A14 installation with readout printer.

Computer Verification *(Continued)*

of the integrator circuits. For these, the printed gain settings must be multiplied by 10.

Another desirable feature of the GEDA A14 problem analyzer is its ability to set accurately the potentiometer values within the networks in which they are to be used. All GEDA A14 potentiometers can be set by using a voltage from the potentiometer itself or by using a voltage from the amplifier to which that coefficient potentiometer is connected. This permits a check on the over-all gain, which is the important factor in setting up any given problem.

To obtain the correct potentiometer setting for the conditions presented in Fig. 3, the operator would turn the computer program control to the CALIBRATE position and introduce an equivalent signal for amplifier 1. He would then select output position 6, by dialing a two-digit code, and adjust the potentiometer until the output of amplifier 6 reaches the desired value when the precisely known test voltage of the input is considered. Nearly all system errors have been eliminated.

Errors in the test-input voltage and the output-monitor voltmeter can be adjusted to less than 0.01%; therefore, the over-all gain setting can be adjusted to within 0.01% of the desired value.

Another significant feature of the A14 analyzer is that while all voltage measurements are made at points of low impedance, all high-impedance elements, such as input resistors and potentiometers, are measured very accurately. Measuring at high-impedance points often introduces hum, cross talk, and signal noise that obscure desired results.

Automatic Checking System

The automatic checking system operates as follows. The problem board to be checked is inserted into the A14 computer. The PROGRAM control is set to CALIBRATE, and all coefficient potentiometers are calibrated; then, the system is set to automatically scan all outputs, and a sequence of operations is performed to check the connections from the output of each amplifier. In the automatic problem-analyzer mode, all relays at outputs of computing elements are turned to the ANALYZE position and an equivalent input is introduced for amplifier 1. The output-monitor switch then automatically scans all computing element outputs; when it finds an element with a voltage greater than 100 mv, it stops, and the voltage is read on a digital voltmeter.

After the digital voltmeter has stabilized, the printer records the following information: (1) the test-voltage origin, (2) the magnitude of the test voltage, (3) the amplifier at which the output is read, and (4) the scale factor, or gain, of the amplifier. The printer then releases the output-monitor switch to search for the next computing element with an output exceeding 100 mv. The operation may be repeated until all outputs have been checked.

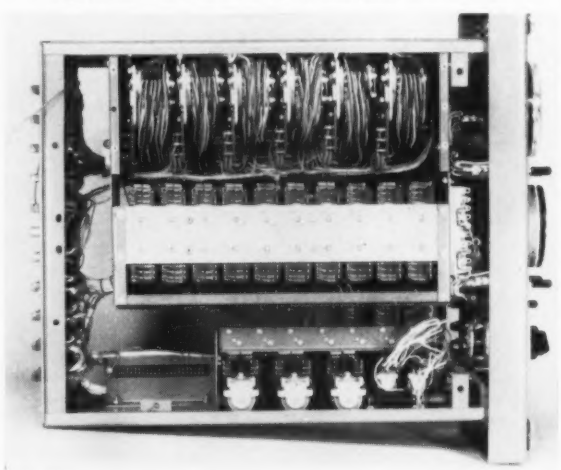
When the scan cycle has been completed, the values of all initial conditions have been checked. The problem board is removed from the analyzer so that the operator may conveniently check it with the printed record and make any corrections indicated.

If it is desirable to store a problem board which has been analyzed in the A14, the checking operation can be repeated. The second printed record then can be compared with the earlier analysis to ensure that wires have not been changed and that potentiometer settings are correct.

Problem-board errors, as pinpointed by the A14 problem analyzer, can be altered in a short time. In earlier systems the operator could only check the second-run results of the stored problem against the earlier results and, if these did not agree, a complete check of the system would be required to find the error.

The A14 problem analysis also can be performed manually.

Fig. 5: Internal view of the A14 side-panel control unit.



Dynamic Testing

After all the elements of a problem have been checked statically, and all input networks and coefficient potentiometers have been adjusted in the CALIBRATE position, a check is made of the dynamic performance of the integrator elements.

The system is switched to the DYNAMIC TEST position, and a voltage is applied simultaneously to the input of all integrators. The outputs of all integrators rise at a controlled rate then are shut off. The automatic scanner will detect the elements that are connected as integrators and can provide a printed record of these elements in one operation. The element numbers then can be checked against the elements shown as integrators in the wiring diagram.

The dynamic check completes the operation performed by the A14 problem analyzer. Thus it can be used to determine that all connections are as shown on the wiring diagram and that no extraneous connections exist. It checks the over-all gains of the system. It accurately checks potentiometer settings and each of the machine components of the system. It can be used to determine whether the proper initial conditions are applied.

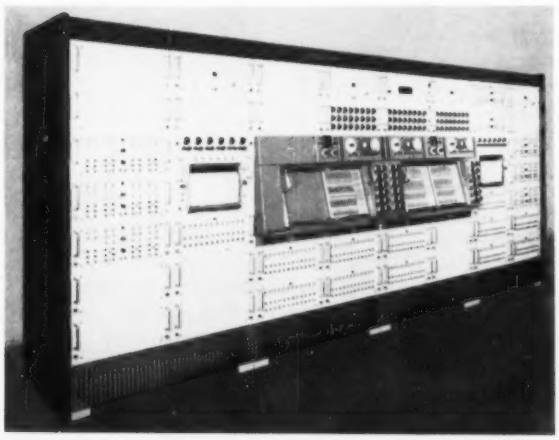


Fig. 6: Perspective of typical medium-sized CEDA A14 installation.

The A14's automatic scanner also can be used in the program control positions STANDBY. I. C. (initial condition), and HOLD. In STANDBY the scanner will detect computing element failure by indicating the presence of an undesired output voltage. In I. C. the scanner will stop at the output of each amplifier where an initial condition exists. In HOLD the scanner will indicate all voltages at the outputs of every element in the machine unless these are negligible.

The operator can obtain a digital record of his problem at any time because switching the system from OPERATE to HOLD causes all computing elements to retain the voltages that existed at the time of switching.

Among the several advantages of the A14 computer that assist the operator in setting up a given problem and assure him that the computer is functioning correctly are the following:

1. The A14 system provides for a change of time scale in a problem by a factor of 10, thus providing the operator with a check on the response characteristics of the problem as set up in the computer.
2. The system provides for the reversal of initial conditions in the problem without wiring changes and thus provides the operator with a check on the linearity of the computing elements for both polarities of output. This is useful in checking special circuits containing diodes.
3. The inherently low differential-operate time (less than 100 μsec) of all HOLD relays assures the operator that errors will not accumulate rapidly if the machine is switched from OPERATE to HOLD repeatedly during the running of a problem.
4. The A14 computer high-speed UTILITY RELAYS can be operated from the control position, or can be operated directly from the output of an operational amplifier.

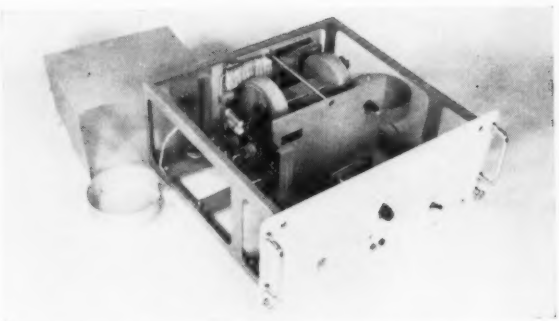


Fig. 7: View of the stabilizer plug-in unit for the Goodyear A14.

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The Editor

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Fig. 3 shows the internal construction and wiring of the side control panel. The major portion of the problem analyzer, the PROGRAM switch, and other control functions are contained in this control panel. Fig. 4 shows the A14 problem board and control panels from the operator's position.

Thus the A14 marks a decided advancement toward greater computer reliability, a factor which has limited the extensive use of electronic differential analyzers since their inception.

Footnotes

1. The scope of problems studied is not, of course, limited to physical problems. Much important work in economic and other nonphysical fields has been carried out with the differential analyzer.
2. Reg. TM, Goodyear Aircraft Corp., Akron 15, Ohio.

By **WILLIAM A. GERARD**
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Westinghouse Electric Corp.
Horseheads, N. Y.

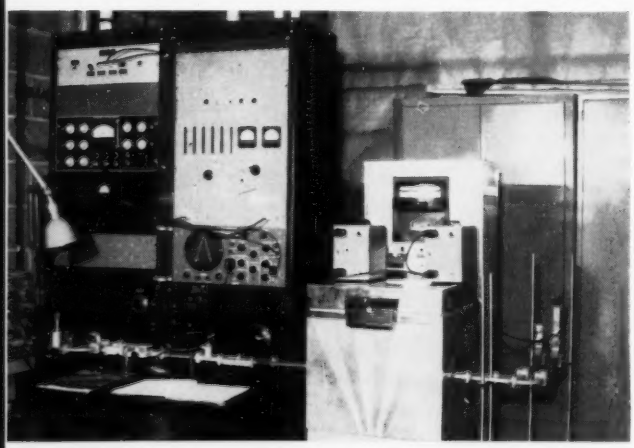
Excellence in stability, temperature compensation, shock, and vibration is determined by measuring the frequency under environmental conditions. Though measurement by frequency change is possible, such systems have proven inflexible. Recent advances in technique and further improvements are noted and discussed.

Measuring Frequency of X-Band

IN the course of the development of a new X-band cavity, the WX3622, much attention has been placed on the measurement of frequency. Since the essential function of a cavity is to serve as a frequency standard, the accuracy of frequency measurement becomes the whole basis for other tests on the device.

It also determines the excellence of the device in stability, temperature compensation, shock, and vibration. If the specified limits on shock were 0.1 MC and the equipment were able to resolve frequency to an accuracy of 0.1 MC, the above limits would have little meaning. Some of these measurements might have been made by measuring the change in frequency, but such systems have proven inflexible when many different frequency cavities are involved. This article is intended to shed more light on the problem, to show what improvements have been made, and which ones are still indicated.

Fig. 1: Equipment and plumbing used in high accuracy cavity test.



System Description

The present system, used by the factory and the engineering laboratory, is similar to the Q meter originally developed by the MIT Radiation Laboratories. It was designed by the Equipment Development Group and extensively modified by the Tube Design Group into its final form.

Referring to Fig. 2, a block diagram of the system, we find a variable l-f oscillator. The oscillator frequency is counted on an electronic counter. The accuracy of this count can be assured by comparison with WWV.

The oscillator frequency is multiplied by a series of r-f stages, the output of which is fed to a 1N21 crystal. This crystal generates harmonics in the X-band which will be compared to the cavity frequency.

Sixty-cycle modulation is applied to the repeller of an X-band klystron (2K25) and to the horizontal deflection plates of an oscilloscope. The modulation is adjusted to sweep the klystron about the resonant frequency of the cavity to be tested.

The modulated klystron output is fed through a ferrite isolator to the test cavity. A directional coupler is included to monitor the klystron output mode. A second coupler couples a portion of the klystron output

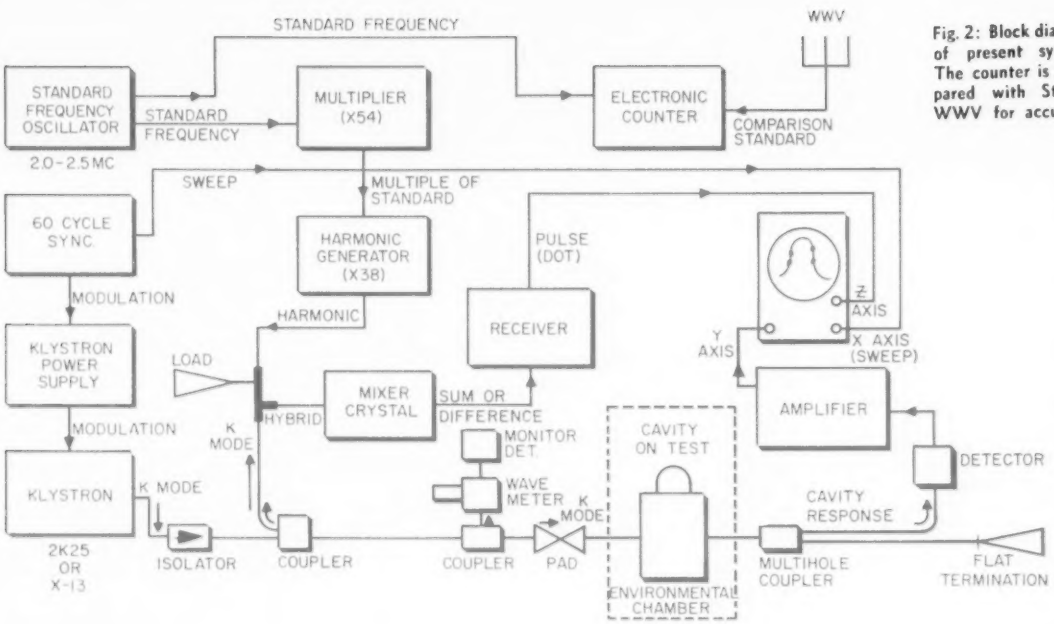


Fig. 2: Block diagram of present system. The counter is compared with Station WWV for accuracy.

Standard Cavities

to a mixer crystal where it is combined with the harmonics of the VFO.

Mixer output is fed to a receiver which is tunable from 2.5 to 3.5 MC. It will respond with a small burst of energy each time the sum or difference of the instantaneous klystron frequency and the harmonic equals the receiver frequency.

This pulse is detected, amplified and used to trigger a thyratron. The thyratron output pulse is fed as intensity, or Z axis, modulation to the scope.

Since sine wave modulation is used, a total of 4 dots will appear on the scope each cycle. This will be shown to aid in eliminating the effects of phase shift in the system.

Klystron energy impinges on the cavity and energy corresponding to the cavity response is transmitted. (This will be true if the cavity is a transmission type device as the WX3622. In any event power aborption will take place and the cavity response can be found by viewing the reflected energy with a directional coupler or by viewing the absorbed energy on a slotted line.) The energy is detected and the cavity response is displayed on the scope. To obtain the frequency reading on the cavity, it is necessary to place both the crystal harmonic and the center of the klystron mode at the cavity frequency as in Fig. 3. Under these conditions, the dots will be symmetrically disposed on the cavity response pattern.

Reading Procedure

Let us trace the procedure used in finding the frequency of a cavity.

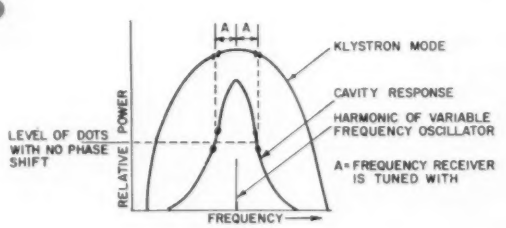


Fig. 3 (above): Symmetrical disposition of dots indicates crystal harmonic & ctr. of klystron mode are at cavity frequency.

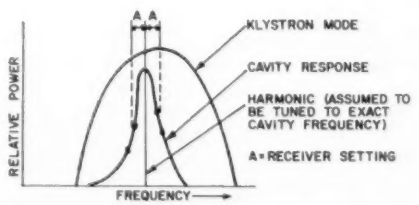
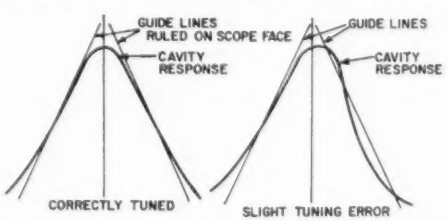


Fig. 4 (above): Klystron not tuned to exact cavity frequency.

Fig. 5 (below): Slanted lines added to scope face reveal slight errors in klystron tuning as skewed patterns.



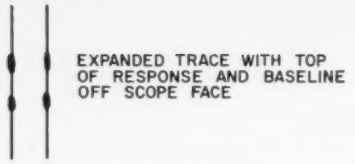


Fig. 6 (above): "Blown up" trace minimizes error in leveling dots.

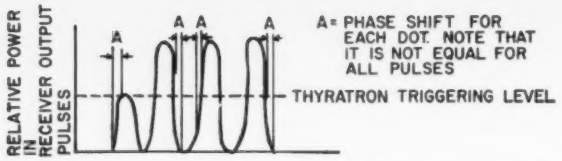

RELATIVE POWER IN RECEIVER OUTPUT PULSES
A
A A
A
A= PHASE SHIFT FOR EACH DOT. NOTE THAT IT IS NOT EQUAL FOR ALL PULSES
THYRATRON TRIGGERING LEVEL

Fig. 7 (above): Differing mixer beat amplitude, shifts receiver phase.

Fig. 8 (below): Pulling of 1Q23 cavity for equal mis-match system.

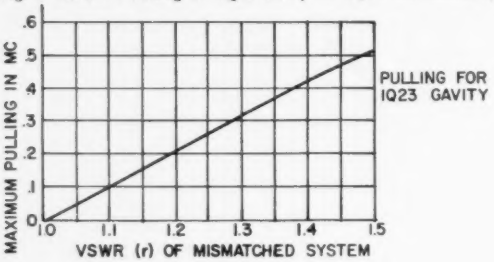
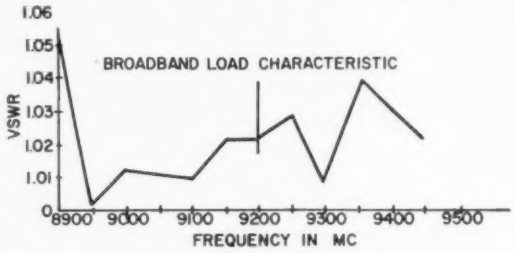


Fig. 9 (below): Note VSWR for load is under 1.05 over a wide band.



X-Band Cavities *(Continued)*

With the cavity inserted in the system as in Fig. 2, the klystron is tuned over the band until a maximum transmission is reached. The cavity frequency may now be determined approximately by use of a calibrated wave meter. Direct reading commercial wave meters are most convenient and they may be precisely calibrated by this method if greater accuracy is desired; 2 MC is usually sufficient. This accuracy is required to establish the correct multiplier or harmonic of the VFO. It is also required to assure that a false harmonic or spurious dots are not being used.

A quick calculation will then yield the approximate VFO frequency that must be used.

$$\text{Approx. VFO frequency} = \frac{\text{Wave meter freq. readings}}{\text{Harmonic multiplier}}$$

The VFO is then set to this frequency. Next, the multiplier chain must be peaked to give maximum current through the harmonic generator crystal. If tuned crystal mounts are used for the harmonic generator and mixer and no dots are visible on the scope it may be necessary to connect a microammeter and tune for maximum current. With dots visible, dot brightness may be used as tuning criterion.

It is sometimes necessary to reduce the klystron modulation to obtain stable dots. This will widen the pulses of receiver energy that form the dots. The VFO is then adjusted to level the dots. The cavity frequency is given by this simple relation:

Cavity frequency = Counter reading × Multiplier

In making the above measurements, numerous sources of error must be considered.

Spurious Dots—False Harmonics

Spurious dots are responses close to the desired harmonic which cause the receiver to trigger. They are usually caused by excessive receiver sensitivity and poor signal to noise ratio.

Identification of the true dots is aided by changing the receiver tuning. As shown in Fig. 3, the dots viewed on the cavity response curve will rise symmetrically when the receiver frequency setting is lowered.

False harmonics are sets of dots which appear on the scope at positions far from the known harmonic settings. Unlike the spurious dots, they are quite stable.

Fortunately, false harmonic and spurious dot errors can be avoided, if care is taken to use the procedure

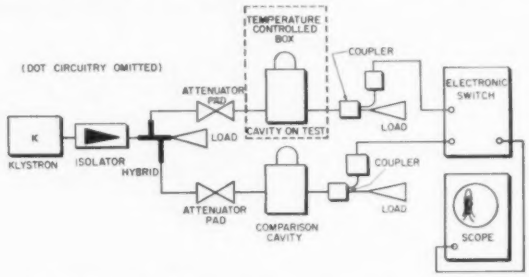


Fig. 10: System for simultaneously testing two or more cavities.

outlined above where frequency is first determined to 2 MC with the wave meter.

Klystron Tuning

If the klystron used were capable of constant power output over the entire frequency range of the cavity response, no error would occur due to slight tuning errors. Two problems arise due to inadequate klystron performance. Fig. 4 shows the results if it is not tuned to the exact cavity frequency.

Since the power level is not equal on each side of the cavity response curve, the dots are not level. When they are leveled, the frequency reading will be in error. A second source of error arises if the klystron mode itself is not symmetrical. In this case, it is impossible to correctly read the cavity frequency by this method.

One solution to this problem is immediately suggested by the diagrams. If the relative position of klystron mode and cavity response are viewed simultaneously on the scope, it is possible to more intelligently tune the klystron.

Such a scheme is possible using a dual beam scope or an electronic switch and a monitor coupler in the waveguide. This scheme was ultimately adapted as the most accurate method.

A second scheme, which does not require the additional equipment was also tried. Two slanting lines are added to the scope, Fig. 5. The presentation is blown up to make the cavity response correspond to the slanting lines. Under these conditions, slight errors in klystron tuning are magnified into skewed patterns. Also, the lines serve as a standard to eliminate operator judgment.

This method requires very symmetrical klystron modes. The X-13 klystron was found to be better than the 2K25 in this respect and has much less backlash. Some inherent error is present in either case. Nevertheless, this method was measureably better than the original one.

The theoretically best solution to the problem of klystron tuning would be to obtain constant power output from the signal source. The use of a backward wave oscillator or saturated TWT amplifier was considered but rejected. The chief difficulty with these power sources is that while they will deliver constant power over wide bandwidths, over narrow bandwidth they exhibit minor fluctuations in gain due to slight helix irregularities. A more elaborate scheme using an AGC setup with the TWT might have been successful.

No attempt was made to operate these "ultimate" systems because the 2-trace presentation gave the required accuracy.

Human Error and Klystron Tuning

Using the measurement system as first described, a range of readings on a given cavity at constant temperature will result with repeated measurement by the same or different operators. The scatter is largely the failure to level the dots and to peak the klystron the same each time.

For X-band cavities, this error has been established as ±.06 to ±.08 MC on measurements by our factory operators. Another manufacturer also reported ±.07 MC scatter in readings.

In the laboratory, human error in leveling dots is minimized by using a "blown up" trace, Fig. 6. Several engineers, all experienced with the equipment, were asked to read the frequency of a cavity which was held at constant temperature. The readings were repeated later and then a third time See Table 1.

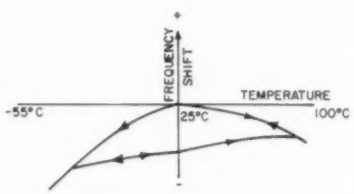


Fig. 11: Characteristic with hysteresis.

These figures show how repeated readings help the human error. Unfortunately, there is no assurance that the average reading is the correct frequency. Asymmetry of the klystron mode or pulling effects could cause such an error.

Using the 2-trace presentations, and carefully leveling the dots appearing on both the cavity response and the klystron mode, it was possible to achieve ranges better than .020 MC and averages within .010 MC. The time spent in adjustments was also reduced to 1/3 the previous time. Identical readings to .002 MC were not uncommon.

Receiver Performance

The receiver which picks up the beat between the klystron and the harmonic plays a vital role in the accuracy of the system. Any time delay in the receiver will result in a delay of the dot on the scope. If the time delay or phase shift were uniform for each pulse through the receiver, the use of sine wave sweep would cause 4 dots to appear. The average height of the dots would represent their position without phase shift.

If the amplitude of the beat from the crystal mixer differs for the 4 dot pulses, the receiver phase shift will also differ. This is largely the result of the thyratron triggering at different times relative to the center of each amplified pulse from the receiver as shown in Fig. 7. This will lead to different apparent frequency readings as the receiver is tuned.

Phase shift varies because klystron power (and hence beat frequency power) varies radically over the klystron mode. Tuning the receiver moves the beat point to new power levels where different phase shifts result. A constant power source is the ultimate solution to this problem.

Pulling Effects

Up to this point, no mention of the requirement of a matched system has been made. The effect is simple—a system presenting any appreciable VSWR to a cavity will pull the cavity frequency if the VSWR phase presents reactance to the cavity.

Table 1

Deviations in MC from Group Average

Engineer	1st Reading	2nd Reading	3rd Reading	Average	Range
A	−.144	−.092	−.040	−.031	.236
B	−.026	−.012	−.010	−.016	.016
C	.012	−.032	.032	.004	.064
D	.058	−.032	−.016	.003	.090
E	.036	.026	−.028	.011	.064
F	.022	−.010	.075	.029	.085

From Vol. 11, page 293 of the M.I.T. Radiation Laboratory Series, we find a formula for maximum pulling:

$$\omega_T = \omega_o + \omega_o \frac{1}{4Q_u} \left[\frac{\beta_1 (r_1^2 - 1)}{r_1} + \frac{\beta_2 (r_2^2 - 1)}{r_2} \right]$$

ω_T = max. pulled angular frequency

ω_o = true resonant angular frequency

Q_u = unloaded Q of cavity

X-Band Cavities *(Concluded)*

β_1, β_2 = input and output coupling parameters

r_1, r_2 = input and output system VSWR

A more convenient form of the formula can be obtained if we consider the case of equal mis-match. Fig. 8 is a curve showing this effect.

$$\Delta f_{max.} = f_o \left[\frac{r^2 - 1}{r}\right] \left[\frac{4 + T_o (\rho + 1)^2}{16 (\rho + 1) Q_L}\right]$$

f_o = resonant frequency

T_o = cavity transmission fraction

ρ = cavity input VSWR

Q_L = cavity loaded Q

It is important to note that a mis-matched input is just as dangerous as a mis-matched output. To eliminate load matching problems, we are now using flat loads with directional couplers rather than tuned crystal mounts. The tuned mounts are very narrow banded, very sensitive to shock, tedious to adjust, and subject to match change with power level change.

By use of the directional coupler, isolation of the crystal mount and the cavity is assured. A plot of VSWR vs frequency for such a load in shown in Fig. 9. Note that the VSWR is below 1.05 over a wide band.

The problem of matching the input is not as easy to deal with. Use of a tuner would require an auxiliary system and quite an elaborate procedure each time the match were to be checked or frequency changed. A broad band matching system would require well matched pads or isolators.

Most attenuators listed in catalogs have rated VSWR up to 1.1, but better match is available on special order. Several manufacturers can supply pads or isolators with VSWR below 1.03 with a bandwidth over 400 MC.

Leakage—Jitter—Discontinuities

On more highly developed systems, under continuous observation, the existence of jitter or discontinuities in many cavities has become apparent. This phenomenon has been confirmed by others in the field.

The observed effect is this: with temperature changing there is a sudden shift of frequency of 0.1 MC or greater. This effect may be reversible by shocking the cavities.

Use of comparison cavities, Fig. 10, has shown that the effect is not a system fault. Careful investigation has shown that such discontinuities are caused by leakage around the cavity proper. In the 1Q design, it results from slight shifts of the "off resonance" whiskers which are used to suppress leakage. Armed with this information, we were able to design a highly improved means of eliminating leakage.

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Temperature Compensation

Temperature compensation basically requires that a cavity maintain frequency over a range of temperatures. To measure compensation, the cavity must be placed in an environmental chamber where temperature may be controlled. Our equipment is designed to hold the cavity and associated guide in the temperature controlled chamber and allow normal frequency measurement.

The relation obtained between temperature and cavity frequency is parabolic in nature, thus the frequency at temperature extremes does not always represent the maximum deviations from room temperature frequency. Continuous observation or checks at intermediate temperatures are necessary to assure correctness of compensation. The comparison cavity technique is useful when a check on the system is desired.

Cold temperatures make the greatest demand on cavities and on measurement technique. One important precaution that must be taken at low temperatures is to prevent moisture in the test waveguide from condensing on the cavity windows. Should this occur, a downward frequency shift of large magnitude may result, obscuring true cavity performance. We have found that pressurizing the wave guide with dry hydrogen prevents this effect.

Hysteresis—Stability

This improved system has led to more accurate knowledge of cavity performance. Previously, no attention has been paid to such phenomena as hysteresis partly because measurements could not give accurate enough data.

Hysteresis is the property of a cavity which exhibits different room temperature frequencies depending on whether it has just been hot cycled or cold cycled. This deviation is often as high as 0.5 MC, with typical numbers from 0.1 to 0.3 MC. Hysteresis in 1Q cavities has been traced largely to diaphragm work hardening although diaphragm-less cavities do exhibit some hysteresis.

When the hysteresis loops do not close, the cavities may be said to be unstable and exhibit cumulative drift. Such instability has occurred in 1Q production and requires extensive cycling before the hysteresis loops would close satisfactorily. Other cases of instability have been traced over 25 MC with no tendency to close apparent.

Instability in the WX3622 proved hard to detect. Careful measurements revealed that at low temperatures the solder bond between the kovar window and the copper cavity body was distorting the cavity irreversibly. This distortion corresponded to a change in the cavity diameter of .00001 in., too small for a mechanical measurement but detectable by precise frequency measurements. The solution, the use of a strain free window, was proven by the same technique, that of precise frequency measurements that were possible with the improvements described in this article.

* * *

Design Analysis of the Low-Q Circuit

The successful design of a low-Q circuit must take into account six distinct resonant frequencies. Here they are defined and derived, and results of the analysis given in tables and useful design curves.

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Part 1 of Two Parts

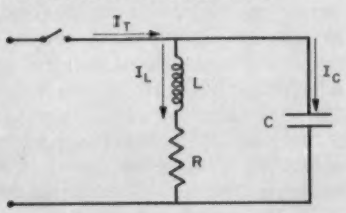
Low Q circuits occur quite often in practical designs. For example, in two terminal coupling of stages of a video amplifier, the analysis of the circuit at the high frequency end of the amplifier reduces to analyzing an equivalent low Q *parallel* RLC circuit. A low Q circuit is needed at the high frequency end of the amplifier to prevent "high frequency peaking." Also, another example is the analysis of a transformer coupled amplifier at its high frequency end. Here the analysis of the circuit reduces to analyzing an equivalent low Q *series* RLC circuit.

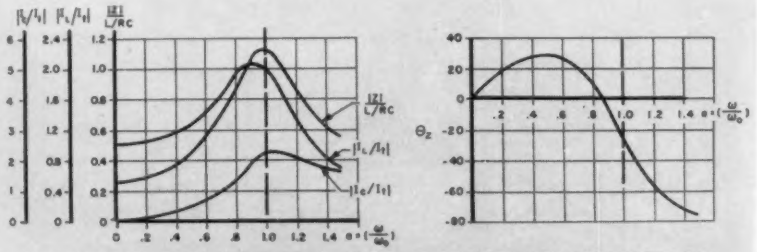
The Parallel RLC Circuit

If the Q of the circuit given in Fig. 1 is high ($Q_0 > 10$), then its resonant frequency is given by $\omega_0 = \frac{1}{\sqrt{LC}}$. At this frequency when the circuit is sinusoidally excited, the following is true. (a) The input impedance of the circuit is a maximum. (b) The circuit operates at unity power factor. (c) The ratio of the current through the inductive branch to the total input current is a maximum. (d)

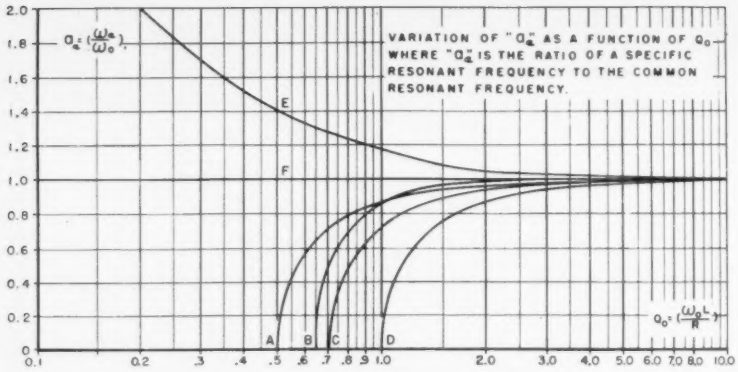
Fig. 1 (below): Parallel RLC circuit.

Fig. 2 (right): Analysis of frequency-dependent characteristics of RLC circuit.



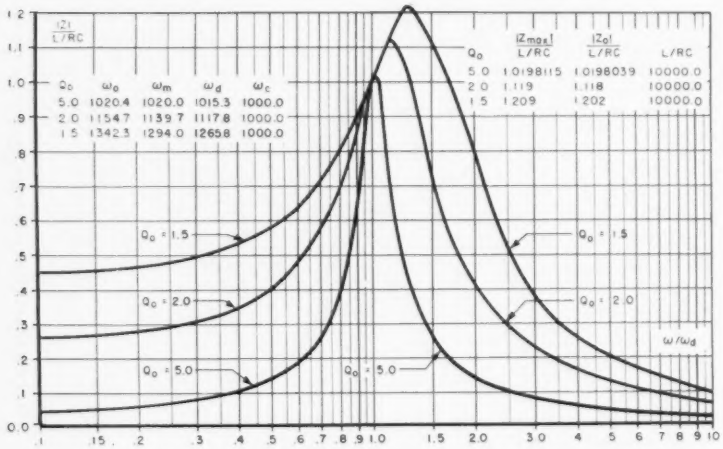


TOTAL INPUT IMPEDANCE, CURRENT RATIO THROUGH CAPACITIVE AND INDUCTIVE BRANCHES, AND PHASE SHIFT AS A FUNCTION OF "a" FOR THE PARALLEL RLC CIRCUIT OF FIG. 1 WITH A Q_0 OF 2.0
("a" IS THE RATIO OF THE APPLIED FREQUENCY TO THE COMMON RESONANT FREQUENCY, $1/\sqrt{LC}$)


VARIATION OF "Q_a''" AS A FUNCTION OF Q_0 WHERE "Q_a''" IS THE RATIO OF A SPECIFIC RESONANT FREQUENCY TO THE COMMON RESONANT FREQUENCY.
$Q_a = (\frac{\omega_a}{\omega_0})$
$Q_0 = (\frac{\omega_0 L}{R})$
A
B
C
D
E
F

A - NATURAL DAMPED RESONANCE, SERIES AND PARALLEL CASE. [FOR a_d]
B - MAXIMUM INPUT IMPEDANCE, PARALLEL CASE. [FOR a_m(PARALLEL)]
C - MAXIMUM CURRENT RATIO THROUGH INDUCTIVE BRANCH, PARALLEL CASE. [FOR a_{I_L}]
C - MAXIMUM VOLTAGE RATIO ACROSS CAPACITANCE, SERIES CASE. [FOR a_{E_C}]
D - UNITY POWER FACTOR, OR ZERO PHASE SHIFT, PARALLEL CASE. [FOR a_C(PARALLEL)]
E - MAXIMUM CURRENT RATIO THROUGH CAPACITIVE BRANCH, PARALLEL CASE. [FOR a_{I_C}]
E - MAXIMUM VOLTAGE RATIO ACROSS COIL, SERIES CASE. [FOR a_{E_L}]
F - MINIMUM IMPEDANCE, UNITY POWER FACTOR, SERIES CASE. [FOR a_m(SERIES) & $a_{C(SERIES)}$]

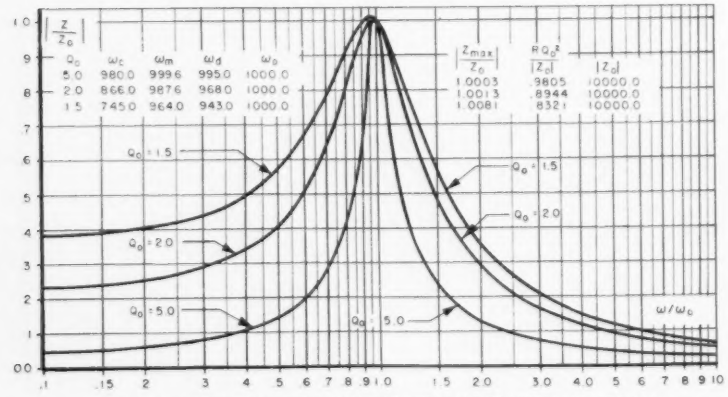
Fig. 3: Variation in ratio of specific to common resonant frequency with Q_0.



PLOT OF THE IMPEDANCE WHEN ASSUMING THE VALUE OF THE IMPEDANCE CONSTANT AT THE UNITY POWER FACTOR FREQUENCY, ω_c, FOR THE PARALLEL RLC CIRCUIT OF FIG. 1 FOR THE VARIOUS Q_0. THE IMPEDANCE IS NORMALIZED ON THE UNITY POWER FACTOR RESONANT FREQUENCY IMPEDANCE, L/RC, AND THE FREQUENCY IS NORMALIZED ON THE UNITY POWER FACTOR RESONANT FREQUENCY, ω_c.

Fig. 4: This plot shows how maximum input impedance varies with Q.

Fig. 5: Variations in impedance for various Q_0.



PLOT OF THE IMPEDANCE WHEN ASSUMING THE VALUE OF IMPEDANCE CONSTANT AT THE COMMONLY ACCEPTED RESONANT FREQUENCY, ω_0, FOR THE PARALLEL RLC CIRCUIT OF FIG. 1 FOR VARIOUS Q_0. THE IMPEDANCE IS NORMALIZED ON THE IMPEDANCE EVALUATED AT THE COMMON RESONANT FREQUENCY, AND THE FREQUENCY IS NORMALIZED ON THE COMMON RESONANT FREQUENCY, ω_0.

Low-Q *(continued)*

The ratio of the current through the capacitive branch to the total input current is a maximum. (e) Also, if the circuit is energized by a DC pulse, the resulting frequency of oscillation in the loop formed by the circuit is essentially ω_0.

Resonant Frequencies

It is rather unique that all of these conditions should occur simultaneously at the same frequency, ω_0, for high Q circuits. The low Q circuit exhibits these same five phenomena, but each condition usually occurs at a different frequency. Hence, there are five resonant frequencies or frequencies of interest for the low Q circuit besides ω_0 or a total of six resonant frequencies.

These frequencies are defined in Table I; carefully detailed derivations of these frequencies in terms of ω_0 and Q_0 are given in Table II. Frequency W_m is the resonant angular frequency for maximum input impedance into the circuit. ω_{IL} is the resonant angular frequency for maximum ratio of current through the inductive branch to total input current of the circuit. ω_{IC} is the resonant angular frequency for maximum ratio of current through the capacitive branch to total input current of the circuit.

Each of these resonant frequencies calls for the maximizing of the input inpedance Z, the ratio I_L/I_T, and the ratio $I_C/_T$, respectively, with respect to frequency. This means that

$$\frac{\partial|Z|}{\partial\omega}, \frac{\partial|I_L/I_T|}{\partial\omega}, \text{ and } \frac{\partial|I_C/I_T|}{\partial\omega} \text{ are}$$

each set equal to zero, and then the respective resonant frequencies are found in terms of ω_0 and Q_0. The derivatives are, then, tested to verify that each of the results gives a maximum.

ω_0 is the resonant angular frequency that gives unit power factor input into the circuit. ω_c is found in terms of ω_0 and Q_0 by equating the imaginary part of Z equal to zero and solving for ω_c. ω_d is the resonant angular frequency at which the circuit oscillates when excited by a DC pulse. Here, it is assumed that the only action of the DC pulse is to charge the capacitor.

Therefore, a transient analysis is performed to find this frequency of oscillation, ω_d.

Design Curves

From Table I, it can be seen that each of the resonant frequencies is a linear function of ω_0. Therefore, a more convenient quantity to use is the reduced frequency, "a". The reduced frequency, "a", offers the advantage of being able to compare various circuits with different ω_0. For example, Fig. 2 gives the behavior of

$$\frac{|Z|}{L/RC}, \left|I_L/I_T\right|, \text{ and } \left|I_C/I_T\right|$$

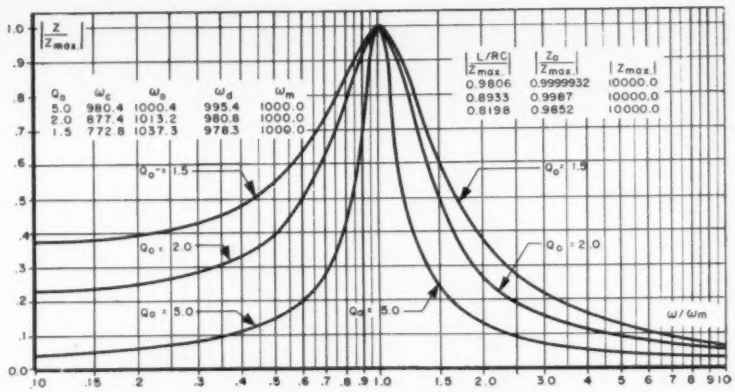
for any ω_0, when the Q_0 of the circuit is 2. Fig. 2, also, shows the input impedance, the current ratio, I_L/I_T, through the inductive branch, and the current ratio, $I/_C I_T$, through the capacitive branch do not maximize at "a"$= 1$, $(\omega = \omega_0)$, nor does zero phase shift occur at "a" $= 1$.

Each resonant reduced frequency is only a function of Q_0. This is clearly shown by Table I, and the results of Table I are graphed in Fig. 3. Fig. 3 is a very useful graph; because, given a particular Q_0, the various resonant frequencies may be obtained at a glance; or vice-versa, given a particular value for a type of resonant frequency, the Q_0 may be obtained. It is interesting to note that when Q_0 is less than .5, only the current ratio, I_C/I_T, through the capacitive branch maximizes at any frequency. Also, the frequency at which the capacitive current ratio, I_C/I_T, becomes a maximum is quite "large" compared to ω_0.

Fig. 4 gives the input impedance at $\omega = \omega_m$ as a function of Q_0. Here it is to be noticed that for Q_0 less than .643594, ω_m is imaginary; but an imaginary ω_m is not sinusoidal excitation. Therefore, the way the derivative of $|Z|$ was obtained would have to be re-examined. Only DC pulses and sinusoidal excitation are considered here.

Fig. 5 gives the input impedance as a function of "a" for various values of Q_0. This curve shows how the maximum input impedance occurs at relative lower values of "a" for lower Q_0. Fig. 6 is similar to Fig. 5, except here the frequency is normalized with respect to ω_c.

(*Continued on page* 114)



PLOT OF THE IMPEDANCE WHEN ASSUMING THE VALUE OF MAXIMUM IMPEDANCE CONSTANT AT THE FREQUENCY, ω_m, FOR THE PARALLEL RLC CIRCUIT OF FIG. 1 FOR VARIOUS Q_0 THE IMPEDANCE IS NORMALIZED ON THE MAXIMUM IMPEDANCE, AND THE FREQUENCY IS NORMALIZED ON THE MAXIMUM IMPEDANCE RESONANT FREQUENCY, ω_m.

Fig. 6: Plot of impedance normalized on the maximum impedance.

TABLE 1

SYMBOLS FOR THE TYPE OF RESONANT FREQUENCY	PHYSICAL DEFINITION OF SYMBOLS	DEFINITION OF THE REDUCED RESONANT FREQUENCY, "a"	FORMULA FOR "a"'s IN TERMS OF Q_0; $(Q_0 = \frac{\omega_0 L}{R})$	FORMULA FOR Z (INPUT IMPEDANCE) IN TERMS OF Q_0 AT RESONANT CONDITION
ω_m	ANGULAR FREQUENCY FOR MAXIMUM INPUT IMPEDANCE INTO THE CIRCUIT	$a_m = \frac{\omega_m}{\omega_0}$	$a_m = \sqrt{\sqrt{1+4/Q_0^4} - 1/2Q_0^2}$	$\frac{Z_m}{L/RC} = \frac{1+\frac{1}{4}\sqrt{Q_0^4+\frac{1}{4}Q_0^2}-1}{Q_0^2\left(1+\frac{1}{2Q_0^2}-\sqrt{1+\frac{1}{Q_0^2}}\right)+\frac{1}{4}\sqrt{Q_0^4\left(1+\frac{1}{2Q_0^2}\right)}-1}$
ω_c	ANGULAR FREQUENCY FOR UNITY POWER FACTOR INPUT INTO THE CIRCUIT	$a_c = \frac{\omega_c}{\omega_0}$	$a_c = \sqrt{1-1/2Q_0^2}$	$\frac{Z_c}{L/RC} = 1$
ω_{I_L}	ANGULAR FREQUENCY FOR MAXIMUM CURRENT RATIO THROUGH THE INDUCTIVE BRANCH	$a_{I_L} = \frac{\omega_{I_L}}{\omega_0}$	$a_{I_L} = \sqrt{1-1/2Q_0^2}$	$\frac{Z_{I_L}}{L/RC} = \frac{1+\frac{1}{4}\sqrt{Q_0^4-\frac{1}{4}}}{\frac{1}{4}+\frac{1}{4}\sqrt{Q_0^4-\frac{1}{4}}}$
ω_{I_C}	ANGULAR FREQUENCY FOR MAXIMUM CURRENT RATIO THROUGH THE CAPTIVE BRANCH	$a_{I_C} = \frac{\omega_{I_C}}{\omega_0}$	$a_{I_C} = \sqrt{\frac{1}{2}\left[\sqrt{1+\frac{2}{Q_0^2}}+1\right]}$	$\frac{Z_{I_C}}{L/RC} = \frac{1+\frac{1}{4}Q_0\sqrt{\frac{1}{2}\left(\sqrt{1+\frac{2}{Q_0^2}}+1\right)}}{Q_0^2\left(1-\sqrt{1+\frac{2}{Q_0^2}}\right)+\frac{1}{4}Q_0\sqrt{\frac{1}{2}\left(\sqrt{1+\frac{2}{Q_0^2}}+1\right)}}$
ω_d	ANGULAR FREQUENCY FOR THE NATURAL DAMPED FREQUENCY	$a_d = \frac{\omega_d}{\omega_0}$	$a_d = \sqrt{1-1/4Q_0^2}$	$\frac{Z_d}{L/RC} = \frac{1+\frac{1}{4}\sqrt{Q_0^4-\frac{1}{4}}}{\frac{1}{4}+\frac{1}{4}\sqrt{Q_0^4-\frac{1}{4}}}$
ω_o	ANGULAR FREQUENCY COMMONLY ACCEPTED AS THE CIRCUIT'S RESONANT FREQUENCY	$a_o = 1 = \frac{\omega_o}{\omega_o}$	$a_o = 1$; $\omega_o = 1/\sqrt{LC}$	$\frac{Z_o}{L/RC} = \frac{1+\frac{1}{4}Q_0}{\frac{1}{4}Q_0}$

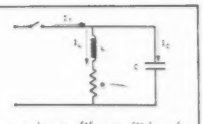
TABLE 2

DERIVATIONS OF THE VARIOUS TYPES OF RESONANTS FREQUENCIES THAT OCCUR IN A PARALLEL RLC CIRCUIT

$$Z = \frac{(Q+\frac{1}{4}\omega L)(\frac{1}{4}\omega_0 L)}{Q+\frac{1}{4}(\omega L-\frac{1}{\omega C})} = \frac{1}{4}R_C\frac{(1+\frac{1}{4}a\,Q_0)}{Q_0^2(1-a^2)+\frac{1}{4}a\,Q_0}$$

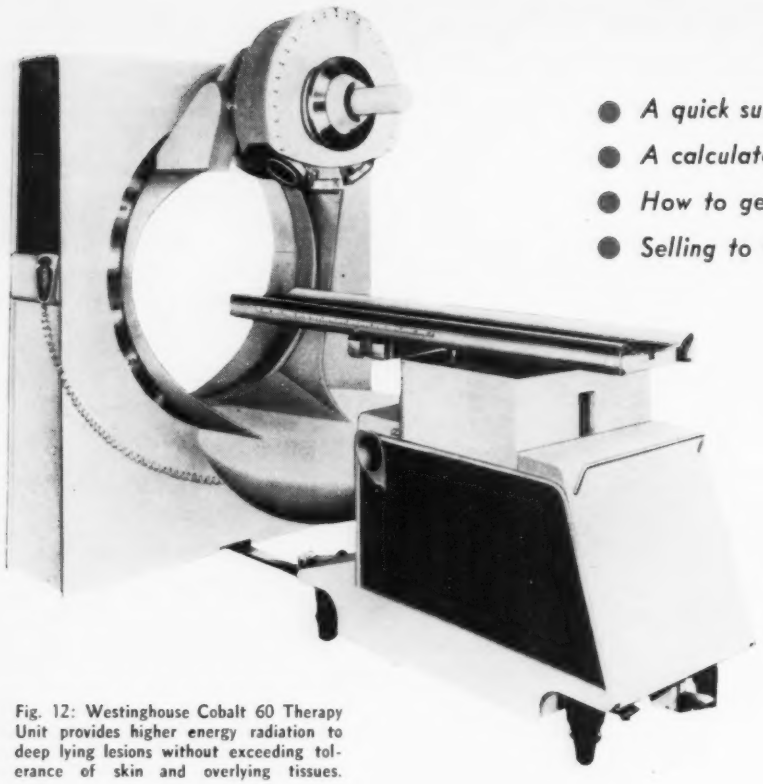
THE FOLLOWING DEFINED NOTATION HELPS SIMPLIFY THE DERIVATIONS OF THE RESONANT FREQUENCIES

$$D(a) = 1+a^2Q_0^2 \;;\; G(a) = a^2+Q_0^2(a^2-1)^2$$



$\omega_0 = \frac{1}{\sqrt{LC}}$; $a = \frac{\omega}{\omega_0}$; $Q_0 = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 RC}$

DERIVATION OF a_m	DERIVATION OF a_c	DERIVATION OF a_{I_L}	DERIVATION OF a_{I_C}	DERIVATION OF a_d
$\left\|\frac{Z}{L/RC}\right\| = a\sqrt{\frac{1+\frac{1}{4}a^2Q_0^2}{Q_0^2(1-a^2)^2+\frac{1}{4}a^2Q_0^2}}$	FOR UNITY POWER FACTOR, Z MUST BE RESISTIVE SINCE	$I_L(R+j\omega L) = I_T R$	$I_C\left(\frac{1}{j\omega C}\right) = I_T R$	A PROOF FOR THE EQUATION GIVING $Q_0 = \frac{1}{2a}$ START WITH THE DIFFERENTIAL EQUATION REPRESENTING THE LOOP FORMED BY THE THREE COMPONENTS OF THE RLC TANK CIRCUIT; BECAUSE A d.c. PULSE IS NOT A SINUSOIDAL EXCITATION, HERE IT IS ASSUMED THAT THE ESSENTIAL ACTION OF THE d.c. PULSE IS TO CHARGE C; SO A TRANSIENT ANALYSIS IS REARRANGED TO FIND "a_d", THE DIFFERENTIAL EQUATION IS
$\frac{d\left\|\frac{Z}{L/RC}\right\|}{da} = \frac{1+\frac{1}{4}a^2Q_0^2}{\sqrt{Q_0^2(1-a^2)^2+\frac{1}{4}a^2Q_0^2}}\left(\frac{\frac{1}{2}aQ_0^2}{1+\frac{1}{4}a^2Q_0^2}-\frac{2Q_0^2(1-a^2)(-2a)+\frac{1}{2}aQ_0^2}{Q_0^2(1-a^2)^2+\frac{1}{4}a^2Q_0^2}\right)$	$\frac{I_L}{I_T} = \frac{1+a\,Q_0\frac{L}{RC}}{1+a\,Q_0\frac{L}{RC}+(a\,Q_0\frac{L}{RC})^2}$	$\frac{I_L}{I_T} = \frac{1}{(1-a^2)+j\frac{a}{Q_0}}$	$\left\|\frac{I_R}{I_T}\right\| = \frac{1}{\sqrt{1+a^2Q_0^2}}\sqrt{\frac{1+a^2Q_0^2}{1+(a\,Q_0-\frac{1}{aQ_0})^2}}$	$\left\|\frac{I_R}{I_T}\right\| = \frac{1}{\sqrt{(1-a^2)^2+\frac{a^2}{Q_0^2}}}$	$O = L\frac{d^2i}{dt^2}+R\frac{di}{dt}+\frac{1}{C}i\,dt$
THEN THE DENOMINATOR MUST EQUAL ZERO, OR THAT	$= \sqrt{\frac{a^2D(a)}{G(a)}}$	$= \sqrt{\frac{Q_0^2}{G(a)}}$	$= \sqrt{\frac{Q_0^2}{G(a)}}$	THE CHARACTERISTIC EQUATION IS
$O = a_m^2(1-a_m^2)-1$	$\frac{d\left\|\frac{I_R}{I_T}\right\|}{da} = \frac{d\left(\frac{a^2D(a)}{G(a)}\right)^{\frac{1}{2}}}{da}$	$\frac{d\left\|\frac{I_R}{I_T}\right\|}{da} = \frac{d\left(\frac{Q_0^2}{G(a)}\right)^{\frac{1}{2}}}{da}$	$\frac{d\left\|\frac{I_R}{I_T}\right\|}{da} = \frac{d\left(\frac{Q_0^2}{G(a)}\right)^{\frac{1}{2}}}{da}$	$O = L\frac{d^2i}{dt^2}+R\frac{di}{dt}+\frac{1}{C}i\,dt$
$a_m^2 = 1-\frac{1}{2Q_0^2}$	SET $\frac{d\left\|\frac{I_R}{I_T}\right\|}{da} = 0$	SET $\frac{d\left\\|\frac{I_R}{I_T}\right\\|}{da} = 0$	SET $\frac{d\left\\|\frac{I_R}{I_T}\right\\|}{da} = 0$	$O = L\frac{dI}{dt}+RI+\frac{1}{C}\int I\,dt$
$a_m = a = \sqrt{1-\frac{1}{2Q_0^2}}$	SINCE $\left\|\frac{I_R}{I_T}\right\|$ CAN BE SHOWN TO BE FINITE FOR REAL "a", THEN	SINCE $\left\\|\frac{I_R}{I_T}\right\\|$ CAN BE SHOWN TO BE FINITE FOR REAL "a" THEN	SINCE $\left\\|\frac{I_R}{I_T}\right\\|$ CAN BE SHOWN TO BE FINITE FOR REAL "a" THEN	THE CHARACTERISTIC EQUATION IS
	$\frac{d}{da}\left(\frac{a^2D(a)}{G(a)}\right) = 0$	$\frac{d}{da}\left(\frac{Q_0^2}{G(a)}\right) = 0$	$\frac{d}{da}\left(\frac{Q_0^2}{G(a)}\right) = 0$	$O = LD^2+RD+\frac{1}{C}$
	OR	OR	OR	OR
	$G\frac{da^2D(a)}{da}-a^2D(a)\frac{dG(a)}{da} = 0$	$\frac{d}{da}(1-a^2)^2+\frac{d}{da}\left(\frac{a^2}{Q_0^2}\right)$	$\frac{d}{da}(1-a^2)^2+\frac{d}{da}\left(\frac{a^2}{Q_0^2}\right)$	$D = -\frac{R}{2L}\pm\sqrt{\frac{R^2}{4L^2}-\frac{1}{LC}}$
	OR	OR	OR	OR
	$O = a^2(2Q_0^2)+a^2(4Q_0^2)-1$	$O = a^2(4Q_0^2)+(1+\frac{1}{Q_0^2})$	$O = a^2(4Q_0^2)+(1+\frac{1}{Q_0^2})$	$D = -\frac{R}{2L}\pm\frac{1}{2L}\sqrt{R^2-\frac{4L}{C}}$
	OR THEN	OR THEN	OR THEN	SO THAT
	$a_{I_C} = a = \sqrt{\frac{1}{2}\left(\sqrt{1+\frac{2}{Q_0^2}}+1\right)}$	$a_{I_L} = a = \sqrt{1-\frac{1}{2Q_0^2}}$	$a_d = a = \sqrt{1-\frac{1}{4Q_0^2}}$	$i = Ce^{-\frac{R}{2L}t}\left[Ae^{\omega_d t}+A_1e^{-\omega_d t}\right]$
				WHERE
				$\omega_d = \omega_0\sqrt{1-\frac{1}{4Q_0^2}}$
				OR
				$a_d = \frac{\omega_d}{\omega_0} = \sqrt{1-\frac{1}{4Q_0^2}}$



- *A quick survey of recent developments*
- *A calculated guess of what's anticipated*
- *How to get into this interesting field*
- *Selling to the medical profession*

By RICHARD G. STRANIX
Assistant Editor
ELECTRONIC INDUSTRIES

Fig. 12: Westinghouse Cobalt 60 Therapy Unit provides higher energy radiation to deep lying lesions without exceeding tolerance of skin and overlying tissues.

A Prospectus on . . .

Medical Electronics

Part Two of Two Parts

ANTICIPATED DEVELOPMENTS

Though no manufacturer will come out and admit what he is actually working on "in the back room," it is generally taken for granted that the most immediate development will be along the computer lines.

Small, relatively inexpensive, special purpose computers will be most in demand because almost all the data that is received by electronic, mechanical, or other physical means will have to be correlated and analyzed.

Computers, of course, merely put the finger on, or rather give the nod to only one phase of development. All types of instrumentation will be a necessity.

Inspection Devices

One of the most immediate applications should be the replacement of visual inspection. This operation requires more time than many of the others, and often it is not dependable or consistent. Scanning techniques hold much promise here. Combination scanners and computers will be needed.

One type of combination equipment, the Cytoanalyzer, Fig. 7, developed by Airborne Instruments Laboratories, is just now making its appearance in the form of two Field Test models. This device automatically scans and handles the data to distinguish between clearly normal smears of exfoliated cells and those smears having some small fraction of abnormal cells. To be of benefit to large screening programs, this must be accomplished with an acceptable level of false negatives.

The function diagram, Fig. 6, of the cytoanalyzer readily shows the operation of the three components: scanner, analyzer, and recorder. Note that nuclear measurement refers to the measurement of the ana-

tomical cell nucleus and not to some form of measurement utilizing radioactive bombardment.

Servos open up a whole new field of application, one of the most apparent of which would be the control of radiation therapeutic devices. Another example, as far-fetched as it may seem at the moment, is suggested by Carl Berkley of the Rockefeller Institute. It is the use of servos for remote control stomach surgery without external incision. Substitution of a receiver for the transmitter in the "radio pill" and further miniaturization make this idea from "science-fiction" not so incredible.

Clinical Centers

Providing credible consistent data is an immediate objective. Without trying to get the labor unions opposed to the field, it would be well if the technicians who presently work on such tasks as blood count could be replaced by scanning devices and data handlers that would give accurate repeatable data consistently. Another major factor is that this information must be able to be obtained economically. This could be a major contribution to medicine. Blood counts are not made anywhere near as often as they should be, merely because the patient will not stand for the added expense.

Presently, blood counts or actually hemoglobin determinations are usually made in two ways. The first, the doctor in his office puts a sample from the patient's finger on a piece of paper and compares its color with colors on a chart. This system has a very low dependability coefficient. The other involves the use of a technician in a central laboratory who places the specimen in a solution and compares its light transmission with a color standard. This system, though much better, still leaves very much to be desired. A hemoglobin determination only indicates normal count if each cell has a normal complement of hemoglobin. The ideal system will utilize scanning and data handling for comparison with an international standard.

Speaking of economics, that is one of the difficulties. We are not able to utilize all our present technology because it is far more expensive than doing it the old way.

Though it may not seem so at first, there are problems outside both the electronic and medical professions that must enter into the picture. Assuming that we now have a central laboratory capable of analyzing, say a blood specimen, packaging and shipping of the sample without qualitative destruction prior to arrival at the laboratory will be a prime requisite.

There will undoubtedly be many equipments designed, built, and manufactured which will not fall into the computer or instrumentation categories. However, these are not generally anticipated at this time. It is well known that many small firms with a good idea often become the leader in the field. Perhaps some manufacturer, small or large, will develop a revolutionary device which will be the "little black box" the medical profession wants for the "little black bags," capable of solving all diagnostic problems and then performing the therapeutic treatment.

Sensory Perception

Another sphere, sensory perception for the blind, though some may feel that this is not truly medical electronics is worthy of mention here. Reading machines which will convert printed matter to Braille are being developed. The "talking book" is objected to by many blind people . . . the interjection of a third person between the author and the intended reader is their complaint.

Since World War II, guidance devices for the blind have been the subject of several programs. Devices more sophisticated than the ordinary cane, are being developed which use sound, light, radio, and radar. One such device, an electronic cane, Fig. 14, capacitive sensitive to the distance between the tip of the cane

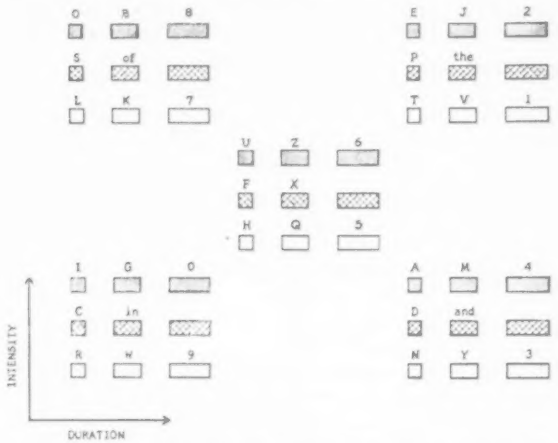


Fig. 13: Perception through the integument is established through the use of 5 vibratory transducers. Psychological experiments at Univ. of Va. have incorporated 3 primary and independent dimensions—amplitude, duration, and bodily locus—in a workable cutaneous communication system. Each group of 9 symbols is to be thought of as belonging to a single vibrator which varies in intensity (3 steps) and duration (3 steps). The 5 vibrators support all letters, all numerals, and the most frequently encountered short words. The vibrators are confined to the ventral thorax. Work was supported by ONR.

and the ground, has shown great promise in the development laboratory. Operating parts, Fig. 15, are contained in the handle. Fig. 16, a block diagram of the system, readily shows operating principle. These devices have been reported in the literature by Wallace E. Frank of the Franklin Institute, Philadelphia.

ENTRANCE REQUIREMENTS

The electronic engineer who would get into the field of medical electronics would do well to take several courses in college Biology. It might well be said that this course is the only essential training required. Of course, it will not immediately show the analogy between electronic theory and anatomical makeup but it will provide the necessary groundwork, or foundation, upon which to build both a vocabulary and a working knowledge of body functions.

Many young engineers today believe that they are the best educated people in all the sciences. Actually, the exposure to the basic sciences that an engineering student receives in college today in very fleeting . . . despite the fact that he may have what he considers

too much . . . a full year of chemistry and a full year of physics.

Classical physics . . . mechanics, electricity, magnetism, sound, light, and heat . . . can not be over emphasized. Sound and light are probably readily understandable as related to the human anatomy. Not so readily understood, or more correctly associated, as mechanical and electrical activity is the movement of any of our extremities by the operation of nerves and muscles. The nervous system study is quite similar to network theory.

Quite naturally, the ultimate in training would be a combination E. E. and medical education. However, this is probably asking too much of the average professional and actually is not necessary. We do not want to frighten away potential field entrants by placing prohibitive educational barriers in the way.

Earnings and Work Classification

At present, there is no great demand for engineers in the medical electronic field. Consequently, their pay scale follows (i.e., is comparable to) that of any other electronic engineer. If they are employed by a commercial firm, they will receive the standard wage rate for other engineers in the company. If they are in the educational profession, they are being, and probably will continue to be, underpaid as they are in every other field of engineering. Some say that the professor is sacrificing pay for security and prestige. More likely, it is a vocation to which they conscientiously devote themselves without thought of personal remuneration.

Because of the terrific expense of research and development work, most of the work in this field must be sponsored by the giants of the electronic industry or under contract by the government. The government will be wielding a double-edged sword in this campaign, for they will also be doing their own R & D work at such places as NIH.

For those engineers who shy away from government work or employment by the mammoths, those who see a better chance for personal recognition in a smaller firm, a word of encouragement. Some manufacturers will be able to realize entrance into the field solely upon the visualization of a clear-thinking engineer who can apply directly, or with slight modification standard production items to a biological problem.

Fig. 14: A guidance device for the totally blind, the sensitive cane, is shown here as actually used.

Lateral Education

The major problems encountered by novices in this field, both electronic and medical, are semantics and actual recognition of what can be done in the other field. These problems are not easily overcome.

There is activity, aimed at educating both the engineer and the biologist. An attempt at formal education has been made at MIT, where a course in Biological Engineering has been introduced. The Rockefeller Institute, clearing house for much of the activity in the field, has been working on a course of instruction called Engineering Biology. The major difficulty has been in finding qualified instructors.

A Research Associate Plan has been inaugurated at NIH. Under this plan, graduate medical students and M.D.'s, interested in widening their knowledge, work in the various laboratories under the direction of the department head.

Recently, RCA conducted a three-day seminar on electron-microscopy. Its participants, sixty, were M.D.'s, and Ph.D.'s from this country's leading medical colleges, and at least five attendees were from foreign countries.

This venture, aimed at educating the educators, proved most successful. Most of us have at least heard of the electron microscope; here was an opportunity for those for whom it can probably do the most good to view the latest techniques, ask questions about it, and actually operate it. Fig. 18 is a scene from the electron microscopy laboratory which shows how CCTV was used to permit the 60 attendees to view operation and image simultaneously, rather

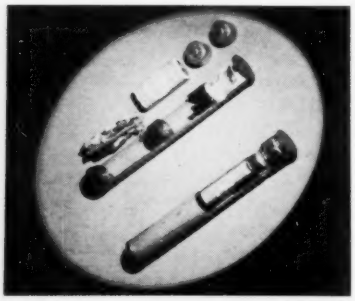
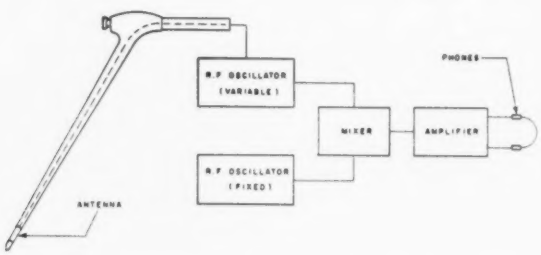


Fig. 15 (left): All of the electronic components for the sensitive cane are contained in the handle.

Fig. 16 (right): On later models, the headphones were replaced with a buzzer mtd. on the handle.



than take turns looking over operator's shoulder.

Annually, there is a Conference on Electrical Techniques in Medicine and Biology sponsored by the Instrument Society of America, the American Institute of Electrical Engineers, and the IRE-PGME, and the Medical Physics Group of the appropriate host city. The sessions of this convention are planned primarily as symposia in which the formal presentations are intended as preliminary steps to the stimulation of discussion and the free interchange of ideas. For each of its ten annual meetings this convention has met with tremendous success.

Remember! This is a team job! It will not be accomplished single-handed.

Contact Development

The first problem that an electronic manufacturer, interested in entering the field, encounters is that of establishing contact with members of the medical profession, or others doing research work in the biological fields.

Perhaps, the fastest and most efficient way is by exhibition at conventions and shows such as the Federation of American Societies for Experimental Biology. Though the firm may actually be making nothing with an actual application in the medical electronics field, its appearance at these shows will draw inquiries . . . even if it is just to ask what they have of interest to the field . . . or why they are displaying at all!

Another method of establishing contact is by personal visits to various research laboratories and universities. It is the opinion of Dr. Lee Lusted, Chairman, IRE-PGME, that most of the advances and contacts in the immediate future will result from this method. By simply taking the time to sit down and discuss the researchers' project and its problems with him, a vast amount of information can be obtained. Naturally, the names of colleagues will enter the conversation and their work may be reviewed simply by referring to the literature. Researchers are only too happy to reveal their problems to those who may be able to assist them in a solution . . . the old story: two heads are better than one.

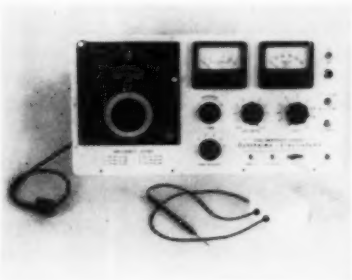


Fig. 17: Ford Instrument Co.'s Ophthalmo-Electrotome, an electrosurgical device, performs the extremely delicate task of reattaching eye retinas.

A third method is that of direct referral—where the medical researcher contacts an electronic firm for help on a specific problem. This is unlikely unless a successful reputation has been developed.

Speaking of reputation, it is particularly important that nothing short of an excellent reputation be developed. This will be quite expensive at first because the equipment must be reliable. Prompt and efficient servicing most likely without charge, must be rendered. Repeated failures of new devices will do more to harm the growth of medical electronics than all the good that it may do, when functioning properly, could have helped.

There are at least two other sources of information which should prove helpful in establishing contact with researchers . . . IRE-PGME and the Rockefeller Institute. The PGME liaison committee could at least supply a list of names and addresses.

Equipment Types

There are two major classifications of equipment that will be needed and used, viz., Research and Clinical.

The former will probably be the most in demand at the earlier date. Medical men are not convinced of an instruments capabilities until it is released by their own researchers. This means that there will be for some time a lot of "one-shot" items. Consequently, the finger again points to the larger manufacturer.

After a category of instruments has been released, then the more-profitable large-quantity production can begin. This is the best time for the little manufacturer to get his hand in. Different variations, not violating patent rights, can then be put on the market. It is probably not necessary to mention the little refinements, such as polished wooden boxes or cabinets as opposed to gray wrinkle finish chassis, necessary for the aesthetic appeal that is demanded of a physician's office or a clinic.

Problems Encountered

Assuming that a manufacturer is producing items for the medical electronics market, he is now faced with the problems of distribution and sales.

Actually, these problems will not be resolved until more experience is obtained. However, companies that are already distributing are doing it directly, i.e., through their own channels and not through the medical supply houses as might be expected. Some laboratory supply houses have asked electronic manufac-

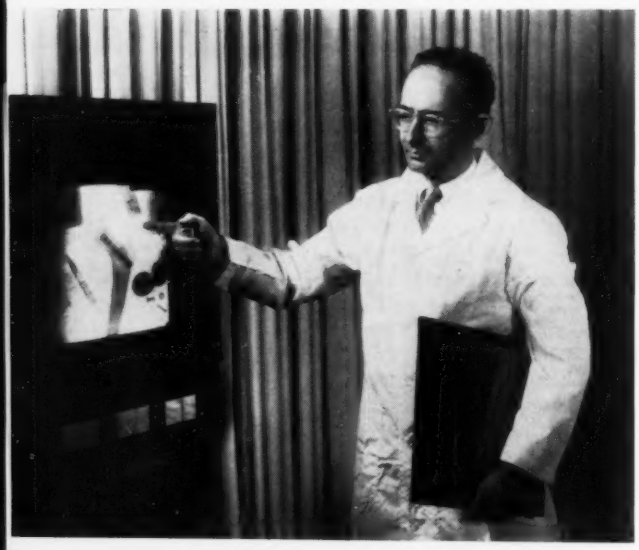
Fig. 18: Electron microscopes were studied at a recent symposium of medical educators. CCTV permitted large audience viewing of image.

turers to supply them with equipment bearing a label which states that the equipment was made for the specific supply house by the electronic manufacturer.

When the field gets larger, the half-dozen medical supply houses that control distribution of items to the medical profession may apply pressure and acquire control. This conceivably might alter the distribution pattern from "manufacturer. mfr. rep., consumer" to "manufacturer, mfr. rep., medical supply house, consumer."

It is unlikely that the medical supply houses will retain a staff of electronic technicians for servicing equipment, and therefore, the electronic manufacturer will either be forced to do it or arrange to have it done by a service organization.

Fig. 19: An experimental amplifying screen for X-ray flouroscopy, capable of increasing by 100 times the brightness of X-ray images for direct viewing in certain types of medical examination, is demonstrated here by a member of the RCA Laboratories technical staff. He holds one of the novel screens; another is shown in operation in chamber containing X-ray equipment and specimens. For this demonstration, the specimens were enclosed in a wood material having X-ray absorption comparable to that of human flesh.



Selling

The common practice today is to use engineers as salesmen, when they can be obtained. These sales engineers may have to sell a purchasing agent, but usually he is just the figure-head. The real selling job is done on the engineer who will be using or specifying the electronic equipment. We then have an engineer talking to an engineer and using a language common to them both.

The basic sales problem will be training engineers to talk to biologist and medical men in a language that they can understand.

Accurate marketing surveys must be made before committing corporate funds to any particular instrumentation program. At the New England Institute for Medical Research Symposium last June, a well-known marketing analyst, L. Nejelski Sr., President of Nejelski & Co. pointed out that the market for any new equipment can be accurately predicted. His company is apparently prepared to make this sort of study on a contractural basis.

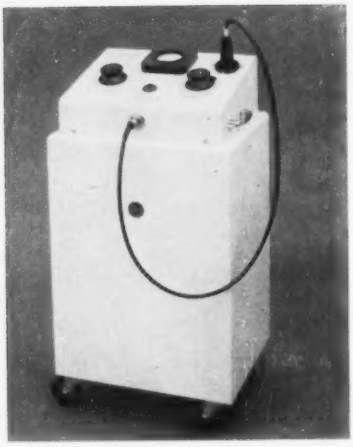


Fig. 20: FCC approval has been received for this 15-watt ultrasonic therapy unit.

As members of the medical profession have said about themselves and their colleagues, "Be careful of M.D.'s! Trust them with your lives, but have no faith in them in business matters." It behooves a corporation to survey elsewhere when investigating the market possibilities of an instrument.

This is a field which, although it is not anticipated to do so, could mushroom overnight. I do not predict that the day that electronics invades the "little black bag" is around the corner, but if the increase in interest and activity of the last ten years is any criterion, the snowball is rolling.

Acknowledgment

The author wishes to especially acknowledge the assistance of the following for their contributions and review of this article:

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Carl Berkley, Rockefeller Institute.
Joseph F. Fisher, Philco Corp.
Wallace E. Frank, Franklin Institute.
John H. Busser, American Electronics Laboratory.

Footnotes

1. A simple scan can be made in 10 seconds but more information is needed to make an array.
2. W. Welkowitz, "Ultrasonics in Medicine and Dentistry," *Proc. of IRE*, Vol. 45, No. 8, pp. 1059-1069, August, 1957.
3. Presently there are two schools of thought on the subject of the effects of ultra-sound—one holds heating to be primary; the other, vibratory motion.

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Protecting Power Transistors From Thermal Runaway

"When the product $VS^{\theta}bI_{co}$ equals or exceeds one, runaway occurs." The designer of power transistor stages must minimize each factor in this crucial term to prevent runaway.

By PAUL PENFIELD, JR.
Electronics Engineer
269 Westgate West
Cambridge 39, Mass.

DESIGNERS of high-power transistor stages find that a knowledge of electrical characteristics is not enough. They run into puzzling heat problems, and, in extreme cases, find a transistor stage is unstable; it may heat up excessively and run away.

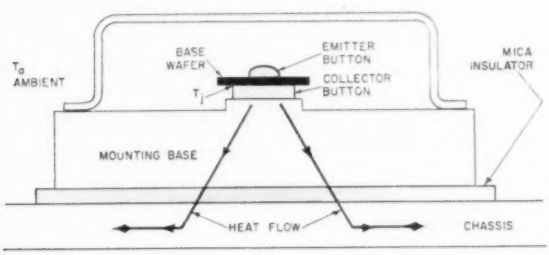


Fig. 1: Typical transistor cross-section showing path of heat flow.

Cause

Thermal runaway in transistors comes about because an increase in temperature brings an increase in cutoff current. This increase means an increase in collector current—sometimes just as much as the increase in cutoff current, and sometimes many many times more. This increased collector current raises the power dissipation at the collector junction, and this in turn increases the junction temperature—and so round and round in a vicious circle, adding to the junction temperature in an infinite series of steps. If this is a convergent infinite series of increases in junction temperature, fine. But if not, we're in trouble. The case where the series is divergent represents thermal runaway.

Fortunately, the problem can be put into mathematical form, so we see just what variables are concerned, and how they are related.

Fig. 1 shows a cross-section of a typical modern junction transistor. The heat flow is assumed to be from the junction to the transistor mounting base to the chassis to the ambient. The temperatures T_j and T_a are measured as shown in Fig. 1.

Thermal Resistance

First, assume that the junction temperature T_j is equal to the ambient T_a plus an amount proportional to the dissipation in the transistor D. The constant of proportionality θ is called the thermal resistance, so

$$T_j = T_a + D\theta. \tag{1}$$

Further, D is equal to the collector voltage V times the collector current I_c, and I_c is equal to I_l plus SI_{co}, where I_{co} is the cutoff current, and S is the stability factor, as normally defined. I_l is that portion of I_c controlled by the base current.

But I_{co} is approximately exponentially related to the temperature, so it can be written in the form

$$I_{co} = Ae^{bT_j} \tag{2}$$

where A and b are constants for any given transistor. Actually a more sophisticated analysis is necessary

Thermal Runaway *(Continued)*

here, taking into account change in semiconductor properties with temperature[1] and thermally-generated current from the depletion layer at the collector junction[2]. But in the more simple picture, the constant b depends on the material and the type construction of the transistor, and to some extent on temperature. A depends on the actual cutoff current at some given temperature, and can differ among transistors of the same type number.

By ordinary algebra we find

$$T_j = T_a + VI_l\theta + VS\theta Ae^{bT_j}, \tag{3}$$

relating T_j and T_a. A graph of this equation, Fig. 2, shows the runaway behavior clearly. Note that at low temperatures the asymptotic behavior of the graph is like Eq. (3) without the final term.

Runaway Conditions

Now to determine runaway, we take the derivative $\frac{dT_j}{dT_a}$. If this derivative is infinite or negative, we know we have runaway. By differentiating implicitly, we obtain

$$\frac{dT_j}{dT_a} = \frac{1}{1 - bVS\theta Ae^{bT_j}} = \frac{1}{1 - VS\theta bI_{co}} \tag{4}$$

where I_{co} is that value for the actual junction temperature T_j. When the product $VS\theta bI_{co}$ equals or exceeds one, runaway occurs. This differentiation proceeded under the assumption that as the currents changed, the collector voltage remained constant, and that I_l, the portion of collector current due to base current, is not temperature dependent. Specifically, this excludes stabilization by means of thermistors, diodes, or varistors.

Design Factors

To prevent runaway, all we have to do is keep this product small. That can be done by paying attention to each factor.

Low b: b is a function of the material and the construction of the transistor. Transistors that have small increases of cutoff current with temperature have a low value of b. Often transistors are rated by what temperature difference T_d is necessary to double the cutoff current. In that case,

$$b = .69/T \tag{5}$$

will give the value of b required.

Low I_{co}: This is a matter of choosing transistor and temperature. Remembering that $I_{co} = Ae^{bT_j}$, keeping A small means selecting a transistor that has, normally, a small cutoff current at any given temperature. Keeping T_j small merely involves keeping the junction cool in the first place. This limitation on T_j may impose a restriction on temperature below that imposed by the manufacturer in his ratings. The higher the junction temperature, the greater the chance of runaway.

Low θ: θ is determined by the mechanical configuration between the transistor collector junction and the ambient heat sink, whatever that may be. It involves not only the mounting base of the transistor proper, but also cooling fins, chassis, and even air streams. Usually a primary objective of the design must be to get a low thermal resistance θ.

Low V: This means, in general, operation at low voltages. For high-power stages, then, high-current, low-voltage operation is preferable to high-voltage, low-current operation.

Low S: The subject of bias stabilization without non-linear elements or temperature-sensitive elements is very important in transistor work. Often the use of thermistors or varistors or similar components is precluded because of the cost, and the designer must bias his transistors with resistors alone. Formulas are available for S for practically any configuration desired, and bias circuit design is usually aided by having a chart of these handy.[3]

For an example, say we have a transistor whose cutoff current at 25°C is 1 ma, and which doubles every 10°C. Assume the total thermal resistance θ is 5°C/Watt, and we have a linear stabilization network with $S = 5$. What is the maximum collector voltage for operation up to 75°C?

Note that the cutoff current at the maximum temperature is 32 times what it is at 25°C, or 32 ma. Now we must keep

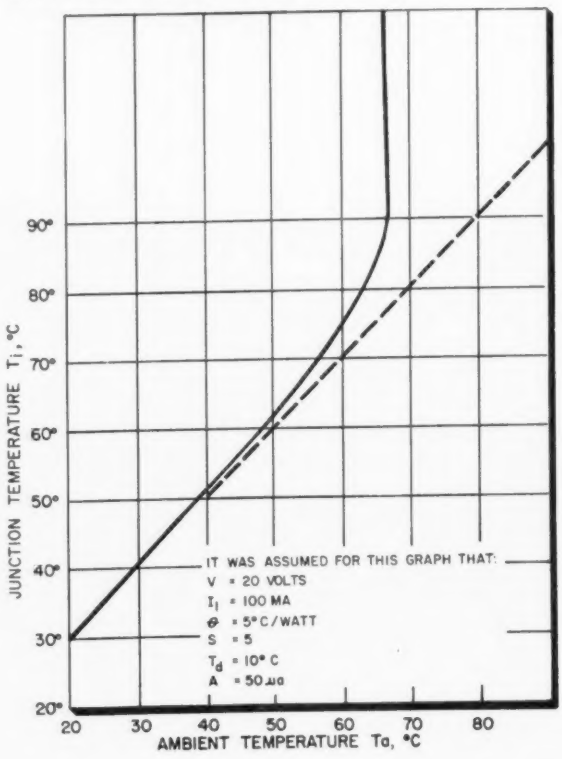
$$VS\theta bI_{co} < 1 \tag{6}$$

for preventing runaway, or,

$$V < \frac{1}{S\theta bI_{co}} = \frac{T_d}{.69\ S\theta I_{co}} = 18.0 \text{ v} \tag{7}$$

(Continued on page 137)

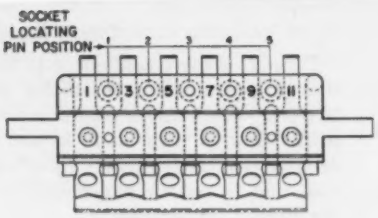
Fig. 2: This graph of equation No. 3, shows both the runaway and asymptotic low-temperature behavior.



. . . LOW INSERTION FORCE WITH POSITIVE BOARD CONTACT-- ACCEPTANCE OF BOARDS OVER A WIDE TOLERANCE RANGE-- HIGH INSULATION RESISTANCE, MULTIPLE POLARIZATION FEATURES, LOW COST--

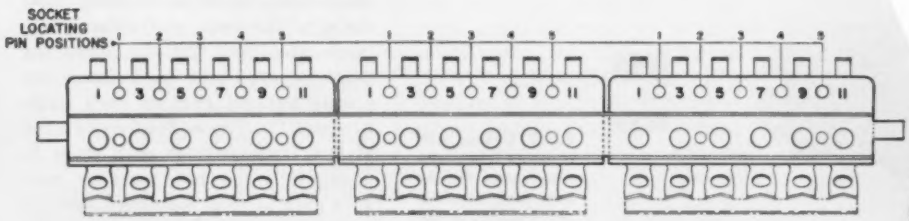
CINCH EDGE CONNECTORS

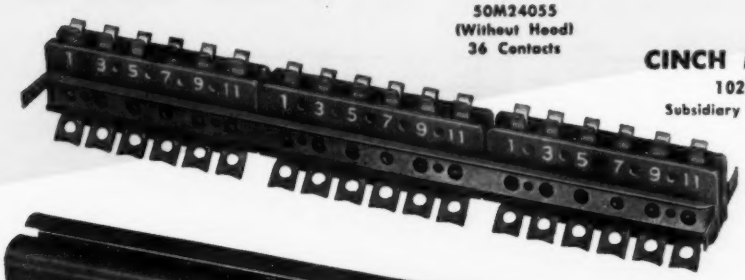
50M24054
(With Cutaway View of Hood)
12 CONTACTS



Drawings actual size. Above No. 50M24054. Below No. 50M24055

are especially suitable for commercial applications. Offer unique design in printed circuit connectors . . . for use with 1/16" two sided copper clad boards. Available in 12 or 36 contact assemblies. Contacts are phosphor bronze with .0003 silver plate plus water lacquer dip. Insulator body is DuPont Zytel No. 101. Contacts are spaced on .250" centers. Molded covers are available for these connectors when they are to be used externally. They provide insulation at the cable end, prevent shorting of the contacts in case the connector is withdrawn and rested on a conducting surface, and provide a convenient handle.





50M24055
(Without Hood)
36 Contacts

50M24055
(With Hood)

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

Nominal Electrical Ratings:
Contact rating ..... .5 amps

Operating Voltage Ratings:

between adjacent contacts	800 VAC RMS
between opposite contacts	800 VAC RMS
between diagonal contacts	1200 VAC RMS
between extreme ends	1800 VAC RMS

Insulation resistance 2,000 megohms minimum.

Centrally located plants at Chicago, Illinois, Shelbyville, Indiana, LaPuente, California and St. Louis, Missouri.

Send for 24 page catalog; "CINCH components for printed circuitry."

Circle 41 on Inquiry Card, page 97

What's New . . .

Clamp-Type AC Microammeter

A PORTABLE, battery-powered, transistorized microammeter developed at the National Bureau of Standards provides a rapid, convenient method for measuring small alternating currents. Since the current pickup is a miniature split-core transformer that can be clamped onto a wire, it is unnecessary to open the circuit to make the measurement. Lowest range of the prototype instrument is 200-μa full scale, and on higher ranges it can accurately determine currents as large as 200 ma. Its frequency range is 50 cps to 100 kc, but the same principles can be used for lower and for very much higher ranges.

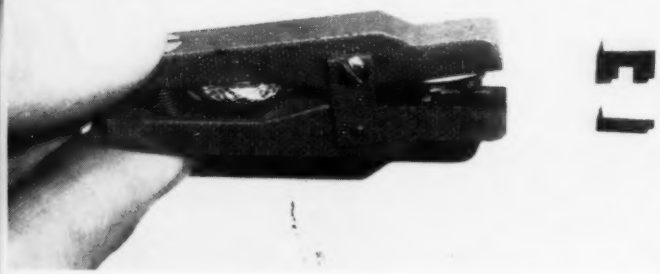


Fig. 1: Closeup view of clamp-type probe. Also shown is the core, made up of C- and I-shaped lamination without windings.

Transformer Design

The transformer core consists of 0.014-in. silicon-steel laminations. It is formed of matching C- and I-shaped sections; the I's close the gap of the C's when assembled. The completed core is 5/16-in. square, 1/8-in. thick, and contains a 1/8-in. window. The core is mounted in a spring-loaded bakelite clamp, about the size and shape of an ordinary clothespin. The matching faces of these parts are ground. Mu-metal shielding minimizes sensitivity to external magnetic fields.

The core C contains two windings, each having 250 turns of number 44 enameled wire. The four coil leads connect to a shielded four-wire cable and plug. One of the windings on the core is considered the secondary, and provides the actual current pickup. The other winding, the tertiary, is part of a feedback network to provide frequency equalization. By using this tertiary winding, transformer output for a particular primary current is very nearly linearized over the frequency range from 100 cps to 100 kc. The primary of the transformer is, of course, the conductor carrying the current to be measured.

Circuit Design

Output of the transformer is fed into a preamplifier consisting of two transistors and a feedback network. Gain in this stage is sacrificed to provide frequency equalization and to reduce phase shift at the higher frequencies.

Gain is provided by two intermediate stages, each using a pair of transistors. Each stage uses direct coupling from the first transistor to the next. A feedback network stabilizes the dc operating point for each pair and reduces the overall current gain of each stage to about 20. The ac feedback factor at low frequency for each stage is about 100; the low-frequency current gain is thus stabilized against transistor and battery aging, and the frequency range for constant

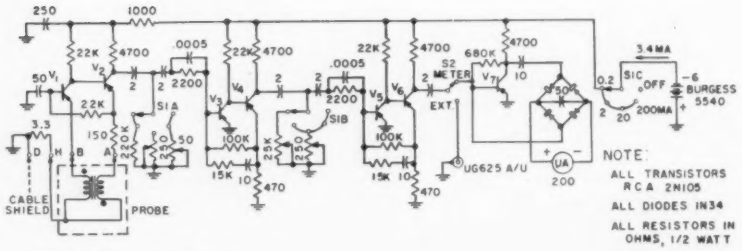


Fig. 2: Schematic diagram of transistorized microammeter.

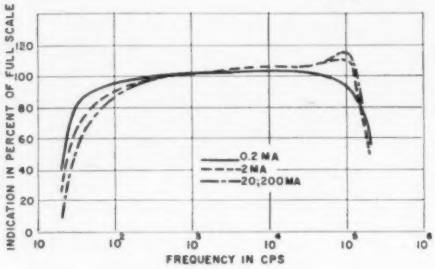


Fig. 3: Graph shows response of instrument over a wide frequency range.

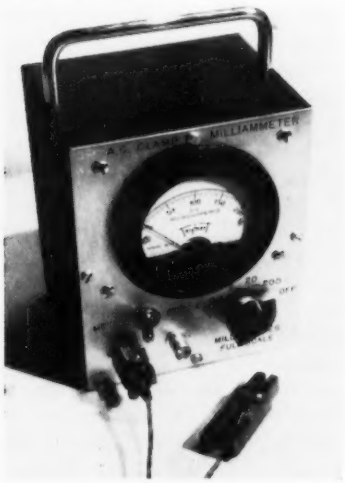
response is extended beyond that available without feedback.

The 200-μa meter is driven through a full-wave rectifier. Although the input current from the intermediate amplifying stages is more than adequate to drive the movement to full scale, it is small compared to the normal operating characteristics of the rectifier. The rectifier, therefore, is operating in a non-linear region. However, the non-linearity is effectively reduced by a one-transistor amplifier whose gain is sacrificed to provide negative feedback through the rectifier. Linearity of response of the entire instrument is within the 2 percent specification of the indicating meter itself.

Performance

Whenever current is measured with any type of instrument, an impedance is in effect inserted in series with the circuit carrying the measured current. For the Bureau's microammeter, the insertion impedance is almost entirely resistive over the useful frequency range. This impedance is made up of a resistance of 2.8×10^{-5} ohm and inductance of 2.2×10^{-7} henry in parallel.

Fig. 4: Photograph of ac microammeter with clamp-type probe developed at NBS. Probe is in foreground.



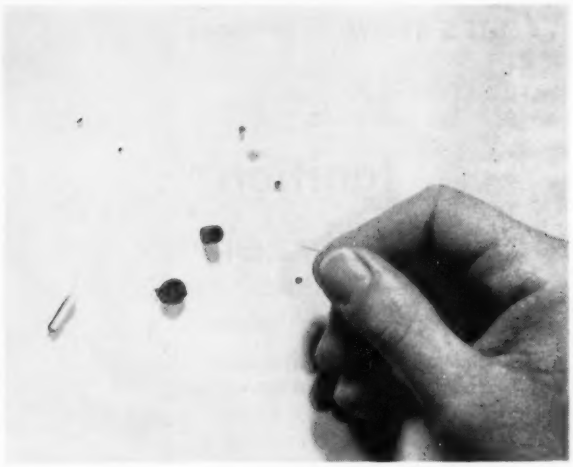


Fig. 1: These coils, in various sizes and shapes, were threaded by SRI's versatile "Pinhole" coil winder.

"Pinhole" Coil Winder

IMPOSSIBLE coils can now be wound with a machine being patented by Stanford Research Institute. It is now perfectly possible to wind a coil through two 0.010-inch holes spaced on 0.060-inch centers in a 3-inch-thick core. The new machine is capable of winding coils whose outside diameter is equal to the diameter of the hole through which they are wound either from the center to the outside of the core, or through two adjacent holes in the same core.

Long Holes

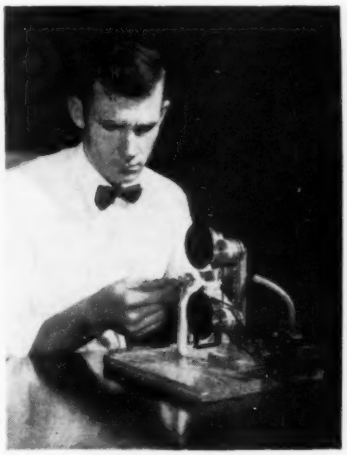
The ability of the machine to wind coils is not impaired by the diameter-to-length ratio of the holes through which the coil is to be wound. Set-up time on the laboratory model of the machine is about the same as on a standard commercial torroidal winding machine, and actual winding time per turn is about equal to a standard commercial machine.

No Bobbin

The new machine has distinct advantages over most machines now on the market, which use a split bobbin. Use of the bobbin limits the size hole through which the coil can be wound to a dimension slightly larger than the combined size of the finished coil and the bobbin. It is also impossible, with ordinary machines, to wind a coil through two adjacent holes in the same surface. With the new SRI machine, the wire forming the coil is made to pull itself through the holes, without any bobbin.

Miniaturization in the electronic industries has been severely handicapped by the lack of machinery to wind multiturn coils through holes in extremely small cores. Application of the new SRI "Pinhole" coil winding machine will eliminate this production bottle-neck.

Fig. 2: Designer M. J. Matovich, of SRI's Computer Development Group, operates the new "Pinhole" Coil Winder.



What's New *(Continued)*

Ignition Analyzer

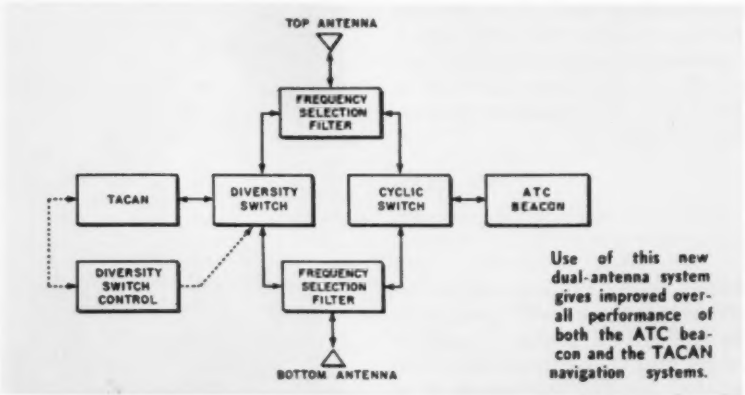
Each separate trace in the IgnitionScope shows ignition in a separate cylinder. From comparing these traces, the auto mechanic can diagnose a wide variety of motor ills.

OUR industry has made a new advance into the automotive field with the introduction of the new DuMont IgnitionScope, a little brother of the EnginScope introduced two years ago. The new instrument gives a multiple-line presentation from which the auto mechanic can analyze the firing of each cylinder. The entire ignition analysis can be made speedily using the unique induction pickup clips which eliminate the need for disturbing the ignition system or piercing the ignition wires. Among the conditions pinpointed by the IgnitionScope display are fouled, misfiring, open, or shorted sparkplugs; defective coils, condensers, wiring and switches; worn distributor cam and shaft bearings, and burned distributor points.

Dual TACAN–ATC Antenna

RESEARCH at Stanford Research Institute has resulted in a new dual-antenna design and an automatic system providing for alternate use on a split-second basis. The new system makes it possible for a single aircraft to be equipped with both the long established air traffic control (ATC) beacon and the new tactical air navigation (TACAN) system.

For some years, the ATC beacon has been utilizing parts of the "L-band," or 960 to 1215 megacycle frequency range. The advent of TACAN created a frequency allocation conflict because the TACAN provides greater accuracy and is less limited by critical ground antenna requirements than current standard navigation systems, it is scheduled to replace these short-range navigation equipments in both civil and military aircraft.



Use of this new dual-antenna system gives improved overall performance of both the ATC beacon and the TACAN navigation systems.

A dual-antenna system — one antenna located on top of the aircraft and one underneath—has been designed, resulting in omnidirectional coverage providing satisfactory reception and transmission regardless of the attitude of the aircraft or of its position relationship to ground sites. The top antenna picks up or transmits signals in the upper hemisphere around the aircraft; the bottom antenna serves the lower hemisphere.

To avoid mutual interference between the ATC beacon and TACAN systems, it was necessary to divide the L-band into two "sub-bands," one for beacon signals and the other for TACAN use. A "multiplexing" or frequency-selection filter unit is required to separate and route the two sets of signals to or from the beacon or TACAN equipments, as appropriate. As signals on both

(*Continued on page* 106)

GENERAL INSTRUMENT
SEMICONDUCTOR DIVISION
proudly announces

the industry's most versatile silicon diode

Uniform excellence in all parameters permitting a far wider range of applications

- REDUCES EXPENSIVE INVENTORY
- REDUCES NUMBER OF DIODE TYPES REQUIRED
- RESULTS IN GREATER STABILITY AND LONGER LIFE

RADIO RECEPTOR'S

silicon diode 1N658

- HIGH FORWARD CONDUCTANCE 100 mA @ 1V.
- LOW REVERSE LEAKAGE .05 μa @ −50V @ 25° C; 25 μa @ −50V @ 150° C.
- HIGH PEAK INVERSE VOLTAGE 120V.
- FAST REVERSE RECOVERY 80K ohms in .3 μsec.*
- HIGH OPERATING TEMPERATURE 175° C.

*When switching from 5 mA to −40V. RL = 2K. CL = 10 $\mu\mu$f.

RATINGS

Maximum inverse working voltage: 100V.
Average forward current: 200 mA.
Maximum power dissipation: 200 mW.

Latest achievement of the GI team of semiconductor specialists is this universal silicon diode 1N658. Radio Receptor's newly developed process combines in skillfully balanced proportion every desirable characteristic you've sought in silicon diodes. Result is a fully reliable component that does a better job in almost every standard application.

In addition to the 1N658, Radio Receptor offers to the industry a full range of RETMA subminiature silicon diode types to meet other applications. Full information is available upon request to Section T-12.

RRco. 1N658 is available now in production quantities for immediate delivery from our factory. Small quantities for testing and evaluation can be purchased from any authorized RRco. distributor and orders sent direct to Radio Receptor will be handled promptly.

RADIO & ELECTRONIC
RR
PRODUCTS SINCE 1922

Semiconductor Division
RADIO RECEPTOR COMPANY, INC.
Subsidiary of General Instrument Corporation
240 Wythe Avenue, Brooklyn 11, N. Y. EVergreen 8-6000

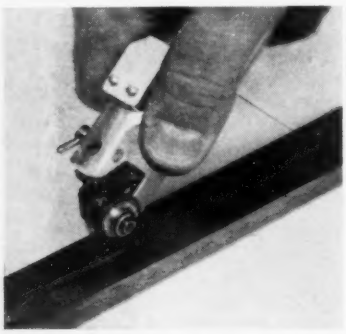
Germanium & Silicon Diodes • Dielectric Heating Generators and Presses
Selenium Rectifiers • Communications, Radar and Navigation Equipment

Circle 42 on Inquiry Card, page 97

New Products . . . for the Electronic Industries

SPOT WELDER

The rollectrode is a new lightweight device which simplifies and automates spot welding operations. It has a self-contained Mil-Spec motor which powers a welding wheel over the surface to be welded. It is compatible



with existing discharge type spot welders. Typical installations involve attachment of weldable strain gages, thermocouples, thermistors, and lead out wires for various electrical devices where adverse environmental conditions, such as shock, extreme temperatures, and high wind velocities exist. Micro-Test, Inc., 657 N. Spaulding Ave., Los Angeles 36, Calif.

Circle 161 on Inquiry Card, page 97

THYRATRON GRID DRIVE

A push-pull all-magnetic thyratron grid drive designed especially for servo applications has been introduced. This full wave, medium gain unit, incorporating a fast response magnetic amplifier, provides a com-

plete servo amplifier for power levels up to 15 kw. when used with appropriate thyratrons. The unit provides a 6 msec. response time for rapid reversing in high performance servo systems. An external resistor provides complete adjustment of null point crossover. Unit occupies 2⅝ x 2¾ x 3¾ in. Fairfield Engineering Corp., 934 Hope St., Springdale, Conn.

Circle 163 on Inquiry Card, page 97

INDICATOR LIGHTS

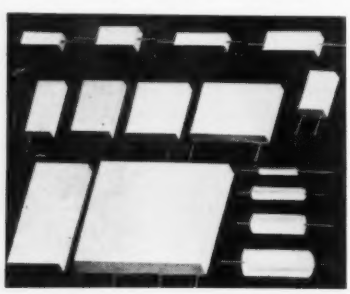
A new series of oil-tight indicator lights for use in heavy-duty industrial applications are in production. Units are permanently oil-tight, water-tight, and dust-tight. Components are made of 1-piece solid brass and fully

gasketed, in a special manner, with oil-proof gaskets. All gaskets are retained, thus preventing loss of seal. Other advantages include: high impact phenolic insulation, streamlined design, compact shape, and rugged construction. The lens may be specified. There is a choice of 7 lens colors. Terminals are either screw or soldering type. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 165 on Inquiry Card, page 97

PRECISION RESISTORS

A new line of smaller, stable bobbinless precision wire fixed resistors featuring a unique "floating" element has been developed. A new patented winding process permits resistance elements and contacts to "float" firmly embedded in epoxy resin, forming a monolithic mass. Wire strain is entirely eliminated. Tolerances down to ±0.05% are available. Closer toler-

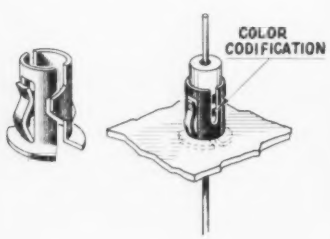


ance or matched multiples are available on request. They have low inductance and low capacitance characteristics. Chicago Telephone Supply Corp., Elkhart, Ind.

Circle 162 on Inquiry Card, page 97

SPEED CLIPS

A new Speed Clip, designed to retain resistors of one and one-half watt sizes to steel, phenolic, fiber or plastic panels is available. Eliminating the need for special collars, grommets and soldering operations, the new clip is merely snapped into a panel hole where it holds itself in position to receive the resistor. The resistor is then inserted into the clip where it is

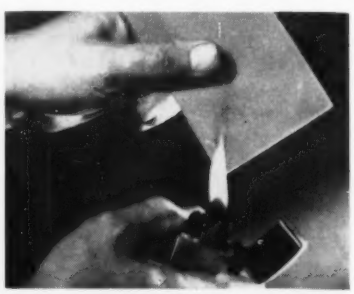


held firmly under live spring tension. Resistors are as easy to remove for service or replacement as they are to assemble. Tinnerman Products, Inc., Cleveland 1, Ohio.

Circle 164 on Inquiry Card, page 97

LAMINATES

A new plastic laminate which combines good electrical characteristics with the added features of flame retardance and arc resistance has been developed. Development of the laminate, known as Insurok Grade XT-901, makes available an electrical grade whose flame retardance properties are unaffected by age or service conditions. Electrical characteristics



exceed the published NEMA values for XXXP phenolic laminates. It can be fabricated readily with usual hot punching equipment. The Richardson Co., 2765 Lake St., Melrose Park, Ill.

Circle 166 on Inquiry Card, page 97

New Products . . . for the Electronic Industries

MULTIPLIER PHOTOTUBE

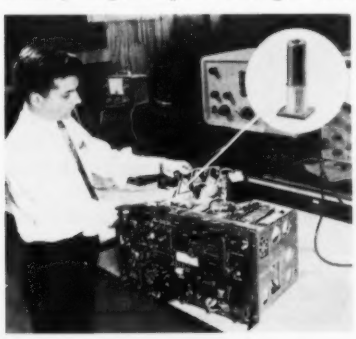
The 7102 is a multiplier phototube of the head-on, 10-stage type intended for use in the detection and measurement of low-level red and near-infrared radiation. It is capable of very short-time resolution and has small

electron-transist-time spread. It has a spectral response covering the range from about 4200 to 11000 angstroms. Max. response occurs in the red region at approximately 8000 angstroms. When operated with a supply voltage of 1500 v. it has a median current amplification of 465,000 and a median luminous sensitivity of 14 a./lumen. Radio Corp. of America, Harrison, N. J.

Circle 167 on Inquiry Card, page 97

FERROMAGNETIC MATERIAL

A powdered iron core of Ferrotron, a new ferromagnetic material, is available. It is powdered iron filled plastic material. It has a constant permeability and high Q, relatively unaffected by long time exposure to temperatures of 200°C. high relative humidities, or aging at high ambient temperature conditions. It has extremely high impact strength and

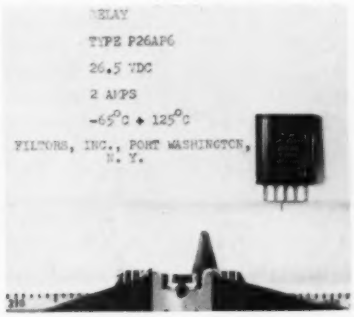


ductility and is machinable by conventional methods. In addition to rigid cores, it is available in flexible rod and tape. The Polymer Corporation of Pa., 2140 Fairmont Ave., Reading, Pa.

Circle 168 on Inquiry Card, page 97

MINIATURE RELAY

Available in 4 mounting styles the new 2-pole d.t. hermetically sealed micro-miniature relay is of rugged construction and has been designed to withstand shock of 50 G's, 11 msec; vibration of 10-55 cps @ 0.06 ampli-

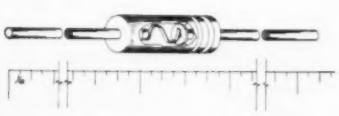


tude and 55—200 cps @ 20G; with an ambient temperature range of −65° to +125°C. Additional "Powrmite" specifications are: dielectric strength, 1,000 v. (750 v. between open contracts); insulation resistance: 10,000 megohms min. @ 25°C; contact arrangement is 2C (2 pole dt) with a contact rating of 2 a. resistive @ 28 vdc. Filtors, Inc., Port Washington, N. Y.

Circle 169 on Inquiry Card, page 97

SILICON DIODE

A multi-purpose subminiature silicon junction diode for computer, communications, military and general circuit requirements, as well as moderate power applications is available. It will handle an average rectified current of 200 ma and has a power dissipation rating of 200 mw. Its operating temperature range is from −65° to 175°C. Forward voltage

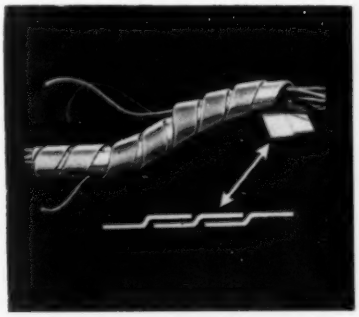


drop is under 1 v. at 100 ma, with a 0.3 μsec reverse recovery. PIV is 120 v. with a reverse leakage of 0.05 μa at −50 v. and 25°C., and 25 μa at −50 v. at 150°C. Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn, N. Y.

Circle 170 on Inquiry Card, page 97

SPIRAL COVER

A new type of wire harnessing product known as Teflon Spiral Cover is now available. It has the feature of overlapping itself 100% forming a double cover over the wire, leaving no open points. Therefore, the in-



sulating qualities are almost equal to solid jacketing. Made only in non-inflammable Teflon in order to meet the growing demand for wire harnessing for high heat applications (200°C.). It has an 0.040 in. wall and is available in 6 different diameters from ¼ to 1½ in. and comes in various lengths. Illumitronic Engineering, 680 E. Taylor, Sunnyvale, Calif.

Circle 171 on Inquiry Card, page 97

SMALL RELAY

A crystal-case size relay that employs a permanent magnet to obtain very high shock and vibration resistance has been announced. The microminiature relay remains operative under shocks of 100G and vibrations of 30G to 2000 cps with no contact openings. Linear accelerations of 400 G do not open the contacts. Designated the SC, the relay measures 0.359 by

0.875 by 0.795 in. It weighs 17.5 grams. It operates on approximately 1 w. It is a dpdt relay capable of switching 2 a. at 30 vdc or 1 a. at 115 vac resistive. Potter & Brumfield, Inc., Princeton, Ind.

Circle 172 on Inquiry Card, page 97

WASHINGTON News Letter

HEAVY SLATE—Congress in its session which stated January 7th has a rather full slate of television-radio-electronics issues before it. From the overall interest of ELECTRONIC INDUSTRIES' readers the most significant legislative proposal before Congress is the joint Senate-House resolution by Sen. Potter of Michigan and Rep. Bray of Indiana, both Republicans, which would create a 3-man commission of outstanding civilian radio engineers to investigate the utilization of the frequency spectrum by the federal government, particularly the military services. The object would be to determine whether more spectrum space can be taken away from the military and government services for TV and for civilian mobile radio and microwave operations.

TELEVISION MAJOR ITEM—Senate Interstate and Foreign Commerce Committee Chairman Warren Magnuson (D.-Wash.) told ELECTRONIC INDUSTRIES that television problems, especially pay-TV, would have assured priority in his committee's deliberations at the new session of Congress. The House Interstate Commerce Committee, together with the House Judiciary Committee's antitrust subcommittee, will also place television matters high on its agenda. Pay-TV is likely to become the most controversial subject to be surveyed by the two Congressional committees. House Committee Chairman Oren Harris (D.-Ark.) started hearings on the FCC plan to accept applications for pay-TV tests in January. Another major television issue will be the results of the FCC network study report, which have been submitted to the Commission by Cincinnati University law dean Barrow and his special FCC staff.

INTERNATIONAL RADIO AGREEMENTS—To prepare the United States position for the international radio conference scheduled for Geneva, Switzerland, beginning July 1, 1959, the FCC has called upon all licensees and manufacturing-research interests to submit their views by January 23rd. The new call for information is separate from the Commission's current inquiry into present and future possible uses of the frequencies between 25 and 890 MC in which the proponderance of data and opinions submitted by nearly 200 parties dealt with allocation problems soluble within the international framework. The new FCC notice is directed particularly with respect to views on possible international changes by the world radio conference on organizational, technical and operating regulations as well as frequency allocation matters.

FINALIZES SPLIT CHANNELS—The FCC before the end of last year met its self-imposed deadline on the replacement of land mobile radio frequencies for those lost to the Office of Defense Mobilization in the recent frequency trade of government and civilian spectrum allocations. They also finalized additional split channels in the 42-50 MC band for the industrial, land transportation and public safety radio services. The finalized new frequencies will be effective April 1, 1958, and embrace split channels in the 42.0-46.51 and 47.0-49.51 MC bands. A significant allocations ruling by the FCC was also that two 90 kilocycle blocks (46.51-46.60 and 49.51-49.60 MC) were reallocated to the international fixed public and aeronautical fixed services to be cleared of mobile services in five years and be available for "scatter" use after Dec. 31, 1958. The FCC in its action also established ten new channels for its proposed new business radio service.

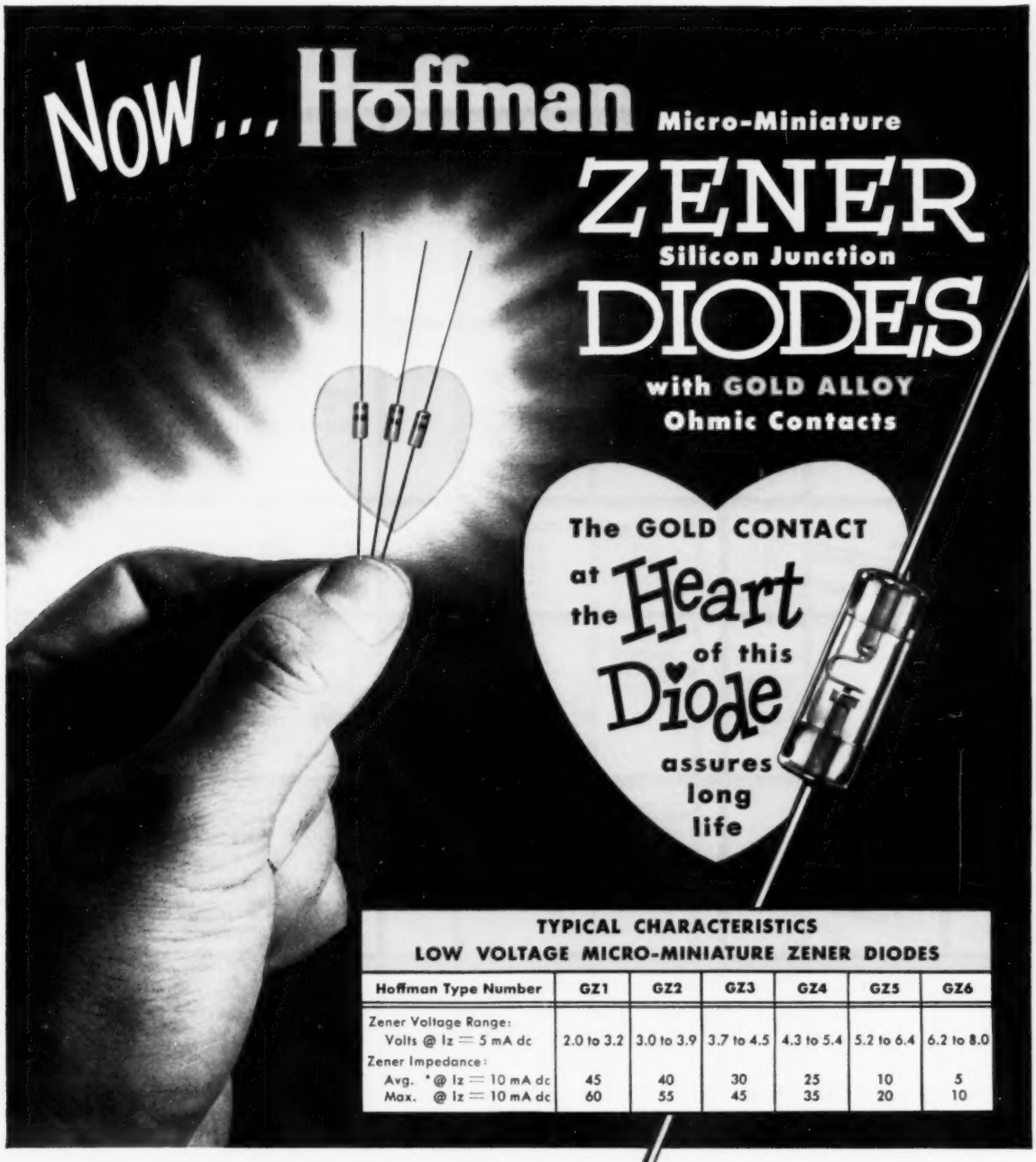
STORM WARNING—Joint planning by the FCC, the U. S. Air Force and the Weather Bureau has resulted in a Commission order enabling radio and television broadcast stations to use Conelrad attention signals preparatory to the broadcast of Weather Bureau emergency warnings of a "condition of immediate danger to life and property." The Conelrad signals would trigger weather emergency warnings to the special alerting radio receivers which serve in the case of enemy bombing or missile attack. Need for the new procedure arose because of the requirements for intensified storm warnings in the case of Florida and Gulf Coast hurricanes and tornado regions.

NO TAX RELIEF—The increased national defense needs which brings greater requirements from the electronics-radio manufacturing industry and research organizations has wiped out all hopes of Congress approving exemption to UHF television for all-channel sets from the manufacturers' 10% excise tax. The House Ways and Means Committee leadership stated that the defense budget requirements wipe out any chances for action on the exemption. But a silver lining for the electronics-radio industry is the fact that the 1958 military expenditures—already 23% of all military procurement dollars—will be increased above the nearly $3.5 billion which was expended in 1957, due to greater emphasis on missile output and weapons systems where electronics are most important.

National Press Building
Washington 4

ROLAND C. DAVIES
Washington Editor

Now... Hoffman Micro-Miniature ZENER Silicon Junction DIODES with GOLD ALLOY Ohmic Contacts



TYPICAL CHARACTERISTICS
LOW VOLTAGE MICRO-MINIATURE ZENER DIODES

Hoffman Type Number	GZ1	GZ2	GZ3	GZ4	GZ5	GZ6
Zener Voltage Range: Volts @ Iz = 5 mA dc	2.0 to 3.2	3.0 to 3.9	3.7 to 4.5	4.3 to 5.4	5.2 to 6.4	6.2 to 8.0
Zener Impedance: Avg. * @ Iz = 10 mA dc	45	40	30	25	10	5
Max. @ Iz = 10 mA dc	60	55	45	35	20	10

Hoffman Electronics CORPORATION

SEMICONDUCTOR DIVISION

930 PITNER AVENUE
EVANSTON, ILLINOIS
UNiversity 9-9850

SPECIALISTS IN SILICON SEMICONDUCTORS

Hoffman Micro-Miniature ZENER Silicon Junction Diodes are made with GOLD ALLOY Ohmic Contacts in order to withstand higher operating temperatures. This line of Hoffman Zener Diodes was developed for *Clipping, Limiting* and *Regulating* and similar applications where physical mounting space is at a minimum.

Rated at 250 milliwatts at 25°C (ambient temperature) and derated at one (1) milliwatt per degree centigrade above 25°C.

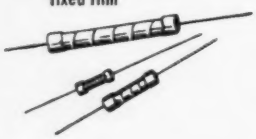
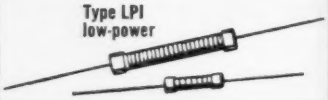
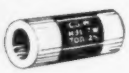
Operating and storage temperature range: −65°C to +200°C.

Special selections from Types GZ1 thru GZ6 are available with a tolerance of ±5%.

Units with ZENER voltages from 8 volts thru 51 volts are available at tolerances of ±10% and ±5%. From 56 volts thru 100 volts at ±10% tolerance.

Write for Hoffman Technical Information Bulletin No. 27-58 for detailed data on this new line of Micro-Miniature Zener Diodes.

Circle 43 on Inquiry Card, page 97

TYPE	USES	FEATURES
Type N fixed film 	High-gain, low-signal amplifiers High-frequency circuits Test equipment Computers Circuits subject to high, instantaneous overloads Industrial Radio and TV Missiles where long shelf-life is required	Extremely low noise level Voltage coefficient less than 0.001% per volt average Long shelf-life Average resistance changes after 5000 hrs. (max. dissipation) is less than 1.0% Manufactured to MIL-R-10509B specification
Type S fixed film	Miniature Power Units High-gain, low-signal amplifiers Computers Missiles where shelf-life is critical Aircraft instruments where weight is critical	Designed for use in high-temperature applications up to 200°C Stability—average change of resistance after 1000 hrs. at max. dissipation is less than 0.5% Manufactured to MIL-R-11804B specification
Type LPI low-power 	Radio, TV and allied industries	Superior high-frequency characteristics Excellent moisture resistance
Type R power resistors	Transmitters Computers R. F. Terminations	Inherent noise level is less than 0.1 microvolt per volt Moisture resistance and overload capacity are exceptional Manufactured to MIL-R-11804B specification
Type H high-frequency high-power 	Dummy Antenna Terminating Circuits subject to steep surges and saw-tooth patterns Power transmitters General RF applications	Can be made to your specs.—with resistance film continuous, spiraled or striped—designed to fit standard fuse clips Stable, rugged, and inherently noninductive Skin effect is negligible Moisture resistant Need no special handling Suitable for water-cooling or operation in oil
Type WC5 water-cooled	Made for mounting directly in a 3" coaxial line May be operated in series to provide a balanced line termination—or in parallel for installations requiring greater power dissipation	Cooled by water flowing in spiral path against the film of resistance material Centrifugal force holds water in intimate contact with entire resistance surface

Save this Resistor

for quick info on six different kinds of CORNING Film Type Resistors for commercial and military use

All offer the ruggedness, small size, big performance, and stability of unique Corning construction.

Fuse a metallic oxide to PYREX brand glass at red heat using various processes and you get the unusual collection of properties shown in the chart.

The resistor is inherently impervious to moisture and to the heat of soldering. It withstands repeated overloads—and the abuse of normal production handling.

	SPECIFICATIONS					
	TYPE	Resistance Min. Max.	Wattage Rating	Size	Temperature Coefficient	Standard Tolerances
Permanent resistance change after standard 5-second overload of 6.25 × rated power averages less than 0.2% Impervious to moisture Available with ± 150 ppm/°C temperature coefficient	N20 N25 N30	10 500K 10 1.5 Meg. 30 4.2 Meg.	(@ 40°C) ½ 1 2	1 9/32 x 1 1/64 1 5/16 x 1 3/64 2 1/16 x 1 3/64	± .03% per °C from — 55 to + 105°C referenced to 25°C	1% 2% 5%
Overload—standard 5 second overload of 6.25 × rated power causes permanent resistance change of less than 0.5% Available with ± 150 ppm/°C temperature coefficient	S20 S25 S30	10 500K 10 1.5 Meg. 30 4.2 Meg.	40°C 120°C 1 ½ 2 1 4 2	1 9/32 x 1 1/64 1 5/16 x 1 3/64 2 1/16 x 1 3/64	± .03% per °C from — 55 to + 235°C referenced to 25°C	1% 2% 5%
Low-cost Easily installed	LPI-3 LPI-4 LPI-5 LPI-7 LPI-10	200 20K 200 50K 200 60K 200 40K 200 70K	3 @ 40°C 4 @ 40°C 5 @ 40°C 7 @ 25°C 10 @ 40°C	1 5/16 x 2 1/64 1 5/16 x 2 1/64 1 3/4 x 2 1/64 2 1/16 x 2 1/64 1 3/4 x 1 3/32	± .025% per °C @ 105°C referenced to 25°C	5% 10%
Average change of resistance after 500 hrs. at max. dissipation at 25°C ambient is less than 3% Standard 5-second overload of 6.25 × rated power causes permanent resistance change of less than 0.5%	R31 R33 R35 R37 R39	10 70K 30 150K 20 300K 20 500K 40 1 Meg.	(@ 25°C) 7 13 25 55 115	1½ x 9/16 3 x 9/16 4 x ⅞ 6 x 1¼ 12 x 1¼	± .03% per °C from — 55 to + 235°C referenced to 25°C	1% 2% 5% 10%
Stability—average resistance change after 500 hours at max. dissipation at 40°C ambient is 3% Standard 5-second overload of 6.25 × rated power causes less than 0.5% permanent resistance change Power ratings may be increased by forced air cooling, or liquid cooling	H31 H33 H35 H37 H39	10 70K 30 150K 20 300K 20 500K 40 1 Meg.	(@ 40°C) DC AC 5 7 10 15 20 30 50 70 100 140	1½ x 17/32 3 x 17/32 4 x 13/16 6 x 1⅛ 12 x 1⅛	± .03% per °C from — 55 to + 235°C referenced to 25°C	1% 2% 5% 10%
Skin effect is negligible Resistance elements are interchangeable	WC5	35 300	5KW			5% 10% 15%

Roundup

The rest is on the chart. There is a greater collection of particulars, including performance graphs, in separate bulletins on the resistors. Send the coupon for copies.

For any of the following resistor bulletins write Electronic Components Sales Department:

☐ Type N ☐ Type S ☐ Type LPI ☐ Type R ☐ Type H ☐ Type WC5

Name ..... Title .....

Company .....

Street .....

City ..... Zone ..... State .....

CORNING GLASS WORKS

95-2 Crystal Street, Corning, New York

Corning means research in Glass

Circle 44 on Inquiry Card, page 97

New Tech Data for Engineers

Ultrasonic Testing

A 2-color, 12-page booklet issued by Sperry Products, Inc., Shelter Rock Rd., Danbury, Conn., entitled Inside Information on Ultrasonic Testing has just been issued. The illustrated booklet presents brief descriptions of the Sperry products, reflectoscopes and accessories, and outlines how any company may utilize ultrasonic inspection at low cost by employing commercial testing services or by leasing test equipment.

Circle 173 on Inquiry Card, page 97

Condensed Catalogue

Cinema Engineering, Div. Aerovox Corp., has published a condensed catalogue of its products. In capsule form, illustrated, it describes the major divisions of its manufactured items. This includes audio and laboratory amplifiers, audio attenuators, resistance decade boxes, degaussers, audio equalizers, power supplies, precision wire-sound resistors, instrument switches, and audio accessories. The Catalogue 22-A is available from Cinema Products, 1100 Chestnut St., Burbank, Calif.

Circle 174 on Inquiry Card, page 97

Digital Tape System

A 16-page brochure describes a new magnetic-tape input/output system for digital computers and related equipment. Manner of achieving buffer-storage reduction, fail-free operation and tranfer rates up to 90,000 characters per second is explained. Individual items of equipment are completely illustrated and described. Extensive specifications are given and alternative equipment choices are compared in tabular presentation. Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle 175 on Inquiry Card, page 97

Accelerometers

Donner Scientific, Concord, Calif. has released Data File 410, a 4-page bulletin containing illustrations, photos, specifications and descriptive matter, covering their line of vacuum tube and transistorized accelerometers.

Circle 176 on Inquiry Card, page 97

Carbon Film Resistors

Bulletin No. DL-C 762 has been issued by the Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex. describing their Mil-Line carbon film resistors. Complete electrical and mechanical specifications are included.

Circle 177 on Inquiry Card, page 97

Silicon Rectifiers

A series of 4 bulletins, 2 colors has been issued by Audio Devices, Inc., 620 E. Dyer Rd., Santa Ana, Calif. describing their new line of silicon rectifiers. Complete electrical and mechanical specifications are given along with graphs and drawings.

Circle 178 on Inquiry Card, page 97

Nickel Cadmium Batteries

Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. has just issued an 8-page, 2-color illustrated bulletin describing the performance specifications, peak discharge currents and construction characteristics of the new battery line. Bulletin VO-100 is complete with photographs, tables, and graphs.

Circle 179 on Inquiry Card, page 97

Speaker Systems

A new, colorful brochure covering University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N. Y., complete line of high fidelity speaker systems and assembled enclosures is now available.

Circle 180 on Inquiry Card, page 97

Laminated Plastics

Case histories of how laminated plastics are used for electrical insulation are described in a new booklet issued by Formica Corp., 4575 Spring Grove Ave., Cincinnati 32, Ohio. The 2-color brochure "It's an Electrical World" shows, through words and pictures, how standard and special Formica materials have been used by a wide range of manufacturers.

Circle 181 on Inquiry Card, page 97

Indicator Lights

Newly designed indicator lights are described in a brochure issued by the Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y. Photographs and diagrammatic drawings are shown of several popular styles of subminiature indicator lights made especially for the NE-2D lamp.

Circle 182 on Inquiry Card, page 97

Rectifier News

The International Rectifier Corp., El Segundo, Calif., has just issued their December-January issue of International Rectifier News, a bimonthly publications. The 2-color, 8-page bulletin contains photographs, tables, and various types of rectifiers.

Circle 183 on Inquiry Card, page 97

Magnetics

A 16-page, 2-color booklet entitled Applied Magnetics is available from The Indiana Steel Products Co., Valparaiso, Ind. Engineers who design magnets for various types of holding assemblies in their products will find the feature article, "Short-cut for Holding—Magnet Design," in the current issue a helpful guide and reference. Complex equations are eliminated by the method discussed. Instead, high school algebra is used to obtain the magnet dimensions.

Circle 184 on Inquiry Card, page 97

Precision Capacitors

A complete product catalogue covering polystyrene, polyethylene, teflon and mylar dielectric capacitors and a line of high voltage packaged power supplies has been made available by Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y. Catalogue provides electrical characteristic data and physical specifications of every type in their line.

Circle 185 on Inquiry Card, page 97

Coil Winders

A catalog sheet illustrating and giving condensed descriptions of 8 coil winding machines has just been released by Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

Circle 186 on Inquiry Card, page 97

Parabolic Antennas

A series of eight 2-color bulletins describing parabolic antennas has been issued by Technical Appliance Corp., Sherburne, N. Y. Bulletins are complete with photographs, specifications, graphs, and tables.

Circle 187 on Inquiry Card, page 97

Precision Ceramic Parts

A new booklet, "Precision Ceramic Parts for Industry," has been issued by Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. The booklet describes various factors involved in the fabrication of precision ceramic parts and vacuum-tight ceramic-to-metal composites.

Circle 188 on Inquiry Card, page 97

Transistor Cartoons

The General Transistor Corp., 91-27 138th Place, Jamaica, N. Y. has just issued a booklet of humorous cartoons on how not to use transistors.

Circle 189 on Inquiry Card, page 97

Setting the standards by which other resistors will be judged!

A major resistor development for major military and commercial equipment producers

Write for Coldite 70+ Resistor Bulletin. Samples for Approval Tests on request to quantity users. Prompt deliveries on small quantities from leading distributors in many cities.

In MIL-R-11B Styles

RC-20
(½-watt)

RC-32
(1-watt)

RC-42
(2-watts)

Electronic Components Division • **STACKPOLE CARBON COMPANY, St. Marys, Pa.**

BRUSHES for all rotating electrical equipment • Custom Engineered CONTACTS • FIXED & VARIABLE RESISTORS • Snap & Slide SWITCHES • Ceramag® Ferromagnetic CORES • IRON CORES • Ceramagnet® Ceramic PERMANENT MAGNETS VOLTAGE REGULATOR DISCS • POWER TUBE ANODES • and dozens of carbon, graphite and metal powder specialties.

Circle 45 on Inquiry Card, page 97

New Tech Data for Engineers

Printed Circuits

Technical Bulletin P-9b entitled "Standard Printed Circuit Tolerances" is available from Photocircuits Corp., Glen Cove, N. Y. Bulletin contains clearly defined guides for design engineers and layout draftsmen in the preparation of original circuit designs. Bulletins are in handy loose-leaf form for ready reference.

Circle 190 on Inquiry Card, page 97

Communication Antennas

The Andrew Corp., 363 E. 75th St., Chicago, Ill. has just issued a 4-page bulletin describing their 25 to 50 mc and 450 to 470 mc antennas for communication usage. Complete electrical and mechanical specifications are included along with prices.

Circle 191 on Inquiry Card, page 97

Potentiometers

Detailed information on the Helipot's newest 3-turn precision potentiometer, the Series 9300, is contained in a 4-page data sheet just issued by the Beckman/Helipot Corp., Newport Beach, Calif.

Circle 192 on Inquiry Card, page 97

Insulation Measurements

A bulletin issued by Mid-Eastern Electronics Inc., 32 Commerce St., Springfield, N. J. describes their Megatrometer which measures insulation from 15,000 to 5 x 10^{15} ohms. Mechanical and electrical specifications are given.

Circle 193 on Inquiry Card, page 97

Image Orthicon

The Radio Corporation of America, Harrison, N. J. has just issued 12-page booklet describing their 7030 image orthicon tube. Booklet is complete with photographs, drawings, circuits, tables, and graphs.

Circle 194 on Inquiry Card, page 97

Silicone Products

Dow Corning Corp., Midland, Mich. has just issued a new 16-page, 2-color reference guide which describes over 150 commercially available silicone products. Bulletin 1-113 contains detailed charts, tables, graphs and data on properties and performance, along with illustrated examples on how silicones can cut costs, simplify design and add new sales appeal in every field of application.

Circle 195 on Inquiry Card, page 97

Selecting Plugs

"How to Select a Cannon Plug" is concisely described in a new 40-page plug guide—an orientation to the 53,000 connectors manufactured by Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. A check-list for selecting the proper plug includes important consideration such as: size, number and style of contacts, mounting space, coupling methods, insulation and environmental conditions. The plug guide also shows photographs of representative connectors, gives basic information on application, and indicates specific catalogs to order for complete data on each series of connectors.

Circle 196 on Inquiry Card, page 97

Resins

"Plastics for Electronics" is a folder containing a large number of data sheets giving information and specifications on casting resins for the electronic industries by Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle 197 on Inquiry Card, page 97

Ceramics

A new 16-page, 2-color manufacturer's ceramic catalog highlighting high alumina bodies in addition to Steatite, Cordierite, and Zirconite ceramics is now available from Centralab, 900 E. Keefe Ave., Milwaukee 1, Wisc. Included are special sections on standard extrusions, ceramic properties and specifications and metalizing, plus a clear-cut method of ordering ceramic pieces.

Circle 198 on Inquiry Card, page 97

Miniature Connectors

A 4-page, four-color illustrated technical brochure gives specifications, diagrams and general information on Continental Connector's expanded line of micro-miniature connectors. Complete information is given. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 199 on Inquiry Card, page 97

Machining Thermoplastics

An 8-page booklet outlines recommended procedures for machining and finishing of thermoplastics sheets, rods and tubes. Procedures discussed include sawing, routing, drilling, turning, shearing, punching, grinding and finishing. Cadillac Plastic & Chemical Co., 15111 2nd Ave., Detroit 3, Mich.

Circle 200 on Inquiry Card, page 97

Vacuum Calculator

A new version of a vacuum calculator is a handy-sized slide-rule for quickly determining the pumping capacity needed to evacuate a given volume to a specified vacuum in a given time, or computing the time required to reach a specific vacuum in a given volume with a pump whose capacity is known. The calculator also contains information on various liquids, their melting and vapor points. F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

Circle 201 on Inquiry Card, page 97

Instrument Line

Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass. has just issued a new catalogue describing their complete new 1958 instrument line for radioactivity detection and analysis. Catalogue A-1 also contains a revised price list.

Circle 202 on Inquiry Card, page 97

Ceramic Manufacturing

General Ceramics Corp., Keasbey, N. J. has just made available a 12-page, 2-color brochure which colorfully depicts the manufacture of ceramics. Information on their line of precision industrial ceramics is also included.

Circle 203 on Inquiry Card, page 97

Laminated Plastics

A 20-page, 2-color booklet issued by Mica Insulator Co., Schenectady 1, N. Y. describes their complete line of thermosetting laminated plastics. Booklet is complete with drawings and sketches, photographs, tables, and charts and other interesting information.

Circle 204 on Inquiry Card, page 97

Slip Ring Assemblies

Slip Ring Company of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif., pictures over 50 slip rings, brushes, commutators and drums in their new brochure. The nine methods of manufacturing these units are disclosed along with the different materials and end uses of the product. Each slip ring is described in detail.

Circle 205 on Inquiry Card, page 97

Composition Resistors

A 4-page, 2-color brochure has been issued by Stackpole Carbon Co., St. Marys, Pa. Brochure contains complete mechanical and electrical specifications on a complete line of fixed composition resistors.

Circle 206 on Inquiry Card, page 97

HYCOR

Delivers Tomorrow's Precision Today

Every month sees new jet planes and missiles that streak farther, faster and higher into space. And with every new advance, there is a new advance in the precision requirements of components that direct, guide and control flight. This is where HYCOR serves. In an ever-broadening line of avionic components, HYCOR supplies precision for the future through progressive design and manufacturing programs. What's more, HYCOR today offers all the added benefits of IRC's long experience and engineering skills in military electronics.

HYCOR precision for the future is available in

encapsulated wire wound resistors featuring high initial accuracy and maximum stability... in encapsulated, cased or uncased toroids with high "Q" factor and temperature stability... in encapsulated, hermetically sealed power transformers... in miniature, custom-designed magnetic amplifiers... in wave and telemetering filters... and in miniature magnetic clutches delivering high torque on low input.

IRC HYCOR

DIVISION OF INTERNATIONAL RESISTANCE COMPANY

12970 Bradley Avenue, Sylmar 1, California

HYCOR COMPONENT	TYPES	RANGE OF USE	FEATURES	DIMENSIONS	CASE
Wire Wound Resistors	Encapsulated MIL-R-93A	¼ to 1 watt, 1 ohm to 20 megohms	Fully protected from humidity, temperature and shock	Small as .160" dia. x .458" in length	Epoxy molding
Toroids	Encapsulated	.00002 to 250 Henries, frequencies up to 150 kc, −55°C to +125°C	High "Q" factors and excellent current and temperature stability	13/16" x 3/8" up	Epoxy molding
	Cased			1 1/8" x 3/4" up	MIL-T-27 type
	Uncased			5/8" x 9/32" up	Wax coating
Transformers	Power	14 V.A., 375 to 525 cps	Humidity proof; for ambient temp. from −55°C to +90°C	1.625" x .860"	Encapsulated
	Ratio	400 to 1000 cps, −55°C to +85°C ambient	Up to 1000: 1 ratio; accuracies to .005%	2.2" x 1.5" x 2.7"	Hermetically sealed
Amplifiers	Magnetic	Power, impedance and response characteristics as specified	Toroidal construction, high quality rectifiers	1.75" x .87" x 2" up	Per military specs
Wave Filters	Low, high and band-pass	200 cps to 100 kc, impedance to 10,000 ohms	Negligible hum in low level circuits	2 3/4" x 2 3/8" x 2 13/16" up	MIL-T-27 type
Telemetering Filters	Low and band-pass	200 cps to 70 kc, impedance 330/330 or 500/500 ohms; also as specified	Excellent phase linearity and attenuation accuracy	3 1/8" x 2 1/2" x 5 1/2" up	Hermetically sealed
Magnetic Clutches	Gear, cable or direct-in-line drives	Up to 15 oz. in. torque on 2 watts or less	5 millisecond response, no clutch slip	1" O. D.	Nylon shell

Your inquiries on ranges outside the above invited.

Circle 79 on Inquiry Card, page 97

MICROWAVE PROGRESS

Impedance Measurements in the 100 — 1000 mc/s Range

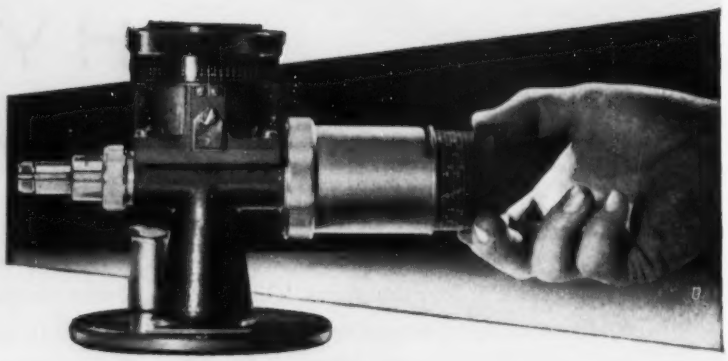
Trying to understand the workings of a woman's mind is like measuring impedance in the 100 — 1000 mc/s range . . . both are fraught with difficulties.

While we haven't, as yet, made any progress on the first problem, we have solved the impedance measurement difficulties with our Type 219 Rotary Standing Wave Detector.

Basically, the 219 consists of a coaxial Tee junction. One arm is fed by the generator. The other two arms are terminated, respectively, by a variable capacitor and by the unknown impedance. Vertically above the Tee junction, is a concentrically mounted round cutoff tube which contains the pickup structure.

It can be shown mathematically that an elliptically polarized field exists in the cutoff tube; and if the variable capacitor is adjusted such that at any frequency its normalized susceptance, as seen at the junction, is equal to unity, then the ratio of the major and minor axes of the ellipse is equal to the VSWR of the load. Further, the geometrical orientation of the major and minor axes of the ellipse with respect to the Tee junction is determined by the angle of the reflection coefficient. A rotating probe samples the elliptical field, and with suitable detection, indicates values of E_r max (electric field vector corresponding to the major axis of the ellipse), and E_r min (minor axis vector), and θ (angle of reflection coefficient). The ratio of E_r max to E_r min is the VSWR of the unknown impedance. The dominant mode in the cutoff tube is the TE_{11} and other modes are eliminated by a mode filter consisting of a series of thin parallel blades mounted in the cutoff tube.

You can obtain additional discussions on the 219, including Theory of Operation, Instrument Accuracy, and Applications, by requesting our PRD Report Vol. 3, No. 8



PRD Rotary Standing Wave Detector for the 100 to 1000 mc/s Range

- Small, Compact, Lightweight*
- Direct Reading of Reflection Coefficient Angle
- Direct Measurement of VSWR
- Non-Ambiguous Display of Inductive or Capacitive Components

Now, a simple-to-use, easy-to-handle standing wave detector for impedance measurements in the 100 to 1000 mc/s range! A turn of the calibrated top drum dial to minimum indication enables you to read the VSWR: and the angle of the voltage reflection coefficient directly in electrical degrees, and, with the 219, you can immediately determine the character of the reactive component as inductance or capacitance (+ or −).

SPECIFICATIONS

Frequency Range: 100 to 1000 mc/s
Residual VSWR: Less than 1.03
Minimum Input Signal: Approx. 1V at 100 mc/s; 0.1V at 1000 mc/s for measuring a matched load.
Characteristic Impedance: 50 ohms
Detector: G.E. G-7 crystal included
RF Input Connector: BNC jack
RF Output Connector: Type N jack. Other interchangeable connectors available.
Audio Output Connector: BNC jack
***Dimensions:** 8" long x 5" wide x 5¾" high
***Weight:** 4½ pounds
Price: $525. FOB Brooklyn, N. Y.

For additional details on PRD 219 Rotary Standing Wave Detector, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. 10.

Polytechnic Research and Development Co., Inc.

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ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

100 **Acme Electric Corporation** — Transformers & transformer devices

11 **Aetna Life Insurance Co.**—Business Life insurance

89 **Airborne Instruments Laboratory, Inc.**—Precision test receiver

85 **Aircraft Radio Corporation** — Ceramic insulated connectors

66 **Alford Mfg. Co., Inc.**—Standby TV antennas

55 **Allen-Bradley Co.**—Composition resistors

88 **Allied Radio Corp.** — Electronic supply guide

53 **American Lava Corporation** — Alumina parts

49 **Amperex Electronic Corp.** — Electron tubes

52 **Arnold Engineering Co.** — Temperature stabilized powder cores

61 **Audio Devices, Inc.**—Magnetic recorded tapes

76 **Augat Bros., Inc.**—Transistor clips

82 **Bead Chain Mfg. Co.**—Contact pins, terminals, jacks and bead chain drives

34 **Blaw-Knox Company, Equipment Division**—Microwave towers

86 **Bliley Electric Company** — Crystals & ovens

90 **Boehme, Inc., H. O.**—Fine pitch precision gears

98 **Bomac Laboratories, Inc.** — Microwave tubes and components

71 **Borg Equipment Div., The George W. Borg Corporation**—Potentiometers and precision turn dials

72 **Borg Equipment Div., The George W. Borg Corporation** — Multi-turn precision potentiometers

12 **Bourns Laboratories**—Multiturn adjustment potentiometer

84 **Bulova Watch Company, Electronics Div.**—"Multi-purpose" oven

14 **Burnell & Co., Inc.**—Crystal filters

8 **Burroughs Corp., Electronic Tube Division**—Indicating tubes

13 **Bussmann Mfg. Division, McGraw-Edison Co.**—Fuses and fuseholders

24 **Cannon Electric Co.**—Plugs and connectors

20 **Chatham Electronics Div., Tung-Sol Electric, Inc.**—Special purpose tubes

59 **Chicago Standard Transformer Corp.**—Filters and audio networks

87 **Chicago Telephone Supply Corp.**—Precision wire fixed resistors

41 **Cinch Mfg. Corp. Subsidiary of United-Carr Fastener Corp.**—Edge connectors

54 **Circon Components Corp.** — Instrument screws

15 **Cleveland Container Co.**—Phenolic tubing

83 **Connecticut Hard Rubber Co.**—Pressure sensitive TEFLON tape

44 **Corning Glass Works**—Film type resistors

33 **Dale Products, Inc.**—Wire wound resistors

17 **Delco Radio Division, General Motors Corp.**—High power transistors

81 **Dialight Corp.** — Sub-miniature pilot lights

48 **Dow Corning Co.**—Silicone dielectrics

35 **DuMont Labs., Inc., Allen B., Industrial Tubes**—Electronic tubes

37 **DuMont Labs., Inc., Allen B., Technical Sales Department**—Oscilloscope

51 **Eitel-McCullough, Inc.**—Ceramic tetrodes

50 **Electro-Motive Mfg. Co., Inc.**—Capacitors

23 **Electro-Voice, Inc.** — Laboratory and production instruments

22 **ESC Corporation** — Custom-built delay lines

69 **E-Z Way Towers, Inc.**—Microwave and communication towers

3 **Ferroxcube Corp. of America**—Miniature transformer cores

31 **Filtors, Inc.**—Micro-miniature relay

103 **Freed Transformer Co.** — Telemetering components

65 **Gates Radio Company**—1000 Watt broadcast transmitter

504 **Garrett Corporation, The**—Engineering personnel

9 **General Chemical Div., Allied Chemical & Dye Corp.** — "Electronic grade" chemicals

503 **General Electric Co., Missile Guidance Product Section** — Engineering personnel

47 **General Transistor Corp.**—Transistors

80 **Graphic Arts Co.**—Visual control board

95 **Graybar Electric Co.** — Industrial television

57 **Gulton Industries, Inc.** — Rechargeable nickel cadmium cell

73 **Heath Company, Subsidiary of Daystrom, Inc.**—Electronic analog computer kit

43 **Hoffman Semiconductor Div., Hoffman Electronic Corp.**—Zener diodes

7 **Hughes Aircraft Company**—Storage type oscilloscopes

502 **Hughes Aircraft Company**—Engineering personnel

79 **Hycor Division of International Resistance Company**—Encapsulated wire wound resistors and components

4 **Industro Transistor Corp.**—Transistors

25 **Institute of Radio Engineers**—I R E Convention

36 **Johnson Co., E. F.**—Variable capacitors

92 **Jones Div., H. B., Cinch Mfg. Co.**—Plugs and sockets

29 **Kearfott Co., Inc.**—Ferrite isolator

18 **Kester Solder Company** — Flux-core solder

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ADVERTISERS IN THIS ISSUE

ADVERTISERS FROM WHOM YOU DESIRE FURTHER INFORMATION

60 **Kennedy & Co., D. S.**—Tracking antenna

21 **Klein & Sons, Mathias**—Shear cutting plier

38 **Kleinschmidt Laboratories, Inc., Subsidiary of Smith-Corona, Inc.**—Page printers and reperforator teletypewriters

75 **Kulka Electric Mfg. Co., Inc.**—Terminal blocks

501 **Lockheed Aircraft Corp.** — Engineering personnel

505 **Melpar Incorporated, A Subsidiary of Westinghouse Air Brake Company**—Engineering personnel

101 **Narda Ultrasonics Corp.** — Ultrasonic cleaning equipment

19 **National Lead Company**—Solder

67 **Onan & Sons, Inc., D. W.**—Electric plants

30 **Philco Corporation, Lansdale Tube Company Division**—Bilateral transistors

46 **Polytechnic Research & Development Corp.**—Rotary standing wave detector

99 **Radio Corporation of America, Semiconductor Division**—Transistors

62 **Radio Corporation of America, Broadcast & Television Equipment** — TV camera

1 **Radio Materials Corporation** — Ceramic capacitors

42 **Radio Receptor Co., Inc., Div. of General Instrument Corp.**—Diodes

94 **Resistance Products Co.**—Resistors for all uses.

5 **Richardson Company, The**—Flame retardent plastic laminate

64 **Rohn Manufacturing Co., Inc.**—Communication towers

16 **Sangamo Electric Co., Electronic Components Div.**—Electrolytic capacitors

28 **Sperry Gyroscope Company**—Klystrons

2 **Sprague Electric Co.**—Film resistors

40 **Sprague Electric Co.** — Solid-electrolyte capacitor

45 **Stackpole Carbon Co.**—Fixed composition resistors

102 **Stanpat Co.**—Drafting transfers

93 **Sta-Warm Electric Co.**—Compound melting equipment

58 **Stromberg-Carlson Co.**—Handsets

6 **Sylvania Electric Products Co.**—Computer transistors

121 **Sylvania Electric Products Co.**—Counter tubes

122 **Sylvania Electric Products Co.**—Microwave tubes

123 **Sylvania Electric Products Co.**—Microwave diodes

39 **Telechrome Mfg. Corp.** — Telemetering transmitters

26 **Tinnerman Products, Inc.** — Transistor mounting clips

27 **Triplett Electrical Instrument Co.**—VOMs

63 **Truscon Steel Div., Republic Steel Corp.**—Steel towers

32 **United States Gasket Co., Div. of Garlock Packing Co.** — TEFLON and NYLON parts and stock

10 **U. S. Components, Inc.**—Printed card connectors

56 **United Transformer Corp.** — Filters, coils and transformers

74 **Westinghouse Electric Corp.**—Electronic tubes

77 **Zippertubing Company, The** — Shielded zipper tubing

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 143 of this issue.

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PROFESSIONAL ENGINEERING OPPORTUNITIES

Please send me further information on the engineering positions I have circled below.

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503	508	513	518	523
504	509	514	519	524
505	510	515	520	525

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New Products and Technical Data—Feb. '58

224 **Amplifier, telemetering** — Telechrome Manufacturing Corp.
225 **Coaxial cables** — Amphenol Electronics Corp.
213 **Capacitors, long life electrolytic**—Cornell-Dubilier Electric Corp.
230 **Capacitors, mica**—General Radio Co.
212 **Converters, static**—UAC Electronics
223 **Counter, electronic**—Burroughs Corp.
221 **Decade box, resistance**—Clarostat Mfg. Co.
235 **Dimmers, light** — Osborne Electronic Corp.
170 **Diode, silicon**—Radio Receptor Co.
168 **Ferromagnetic material**—The Polymer Corp.

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237 **Gain set**—Kay Electric Co.
166 **Laminates**—The Richardson Co.
165 **Lights, indicator**—Dialight Corp.
226 **Magnetizers**—General Electric Co.
209 **Multiplex system**—Kahn Research Labs.
231 **Optical instruments**—Alfred Hofmann & Co.
217 **Oven, crystal**—Manson Labs., Inc.
208 **Power supply**—Allen B. DuMont Labs.
234 **Reactors, switching**—Magnetics Inc.
214 **Recorder, digital**—Hewlett-Packard Co.
232 **Recording heads** — General Transistor Western Corp.
169 **Relay, miniature**—Filtors, Inc.
218 **Relays, sealed**—C. P. Clare & Co.
172 **Relays, small**—Potter & Brumfield, Inc.
233 **Resins, epoxy**—Minnesota Mining & Mfg Co.
216 **Resistors, metal film**—International Resistance Co.
215 **Resistors, miniature**—Dale Products, Inc.
236 **Resistors, plug-in**—Stackpole Carbon Co.
162 **Resistors, precision**—Chicago Telephone Supply Corp.
219 **Sockets, transistor** — Vector Electronic Co.
164 **Speed clips**—Tinnerman Products, Inc.
171 **Spiral cover**—Illumitronic Engineering
161 **Spot welder**—Micro-Test, Inc.
222 **Switches, toggle**—Micro-Switch
229 **Synchro, high accuracy**—Kearfott Co.
163 **Thyratron grid drive**—Fairfield Engineering Corp.
220 **Transformers, molded**—Microtran Co.
238 **Transformers, video**—ESC Corp.
207 **Transmitter, 250 watt**—General Electric Co.
228 **Tube, cathode-ray** — Electronic Tube Corp.
167 **Tube, multiplier photo**—Radio Corp. of America
210 **Tube, power tetrode** — Eitel-McCullough Inc.
227 **Tube, reflex klystron**—Sperry Gyroscope Co.
211 **Warning system** — Packard-Bell Electronics Corp.

NEW TECHNICAL DATA

176 **Accelerometers**—Donner Scientific
191 **Antennas, communication**—The Andrew Corp.
187 **Antennas, parabolic**—Technical Appliance Corp.
179 **Batteries, nickel cadmium**—Gulton Industries, Inc.
185 **Capacitors, precision**—Film Capacitors, Inc.
174 **Catalogue, condensed** — Cinema Engineering
203 **Ceramic manufacturing** — General Ceramics Corp.
188 **Ceramic parts, precision**—Sylvania Electric Products, Inc.
198 **Ceramics**—Centralab
186 **Coil winders**—Geo. Stevens Mfg. Co., Inc.
199 **Connectors, miniature** — DeJur-Amsco Corp.
202 **Instrument line**—Baird-Atomic, Inc.
182 **Lights, indicator**—Dialight Corp.
184 **Magnetics**—The Indiana Steel Products Co.
193 **Measurements, insulation**—Mid-Eastern Electronics, Inc.
204 **Plastics, laminated**—Mica Insulator Co.
181 **Plastics, laminated**—Formica Corp.
196 **Plugs, selecting**—Cannon Electric Co.
192 **Potentiometers**—Beckman/Helipot Corp.
190 **Printed circuits**—Photocircuits Corp.
183 **Rectifier news**—International Rectifier Corp.
178 **Rectifiers, silicon**—Audio Devices, Inc.
197 **Resins**—Emerson & Cuming, Inc.
177 **Resistors, carbon film**—Texas Instruments Incorporated
206 **Resistors, composition**—Stackpole Carbon Co.
195 **Silicone products**—Dow Corning Corp.
205 **Slip ring assemblies**—Slip Ring Co. of America
180 **Speaker systems**—University Loudspeakers, Inc.
175 **Tape system, digital**—Ampex Corp.
200 **Thermoplastics, machining** — Cadillac Plastic & Chemical Co.
189 **Transistor cartoons**—The General Transistor Corp.
194 **Tube, image orthicon**—Radio Corp. of America
173 **Ultrasonic testing** — Sperry Products, Inc.
201 **Vacuum calculator**—F. J. Stokes Corp.

GENERAL TRANSISTOR'S
PRODUCTION
Breakthru
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2N 445
2N 446
2N 447
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Management recognized that a surge of increased business could strain manufacturing and quality control facilities. Before a bind could develop, "operation breakthru" was inaugurated . . . and can now be called a complete success.
Another modern manufacturing plant was added to General Transistor's 3 plants — this additional facility increases storage area, expands the quality control section and enlarges the manufacturing space. Additional equipment and machinery have been purchased. Technical and labor force have been increased to satisfy the demand of industry.
Operation breakthru is a success — your assurance of continued reliable production, prompt deliveries and realistic prices.
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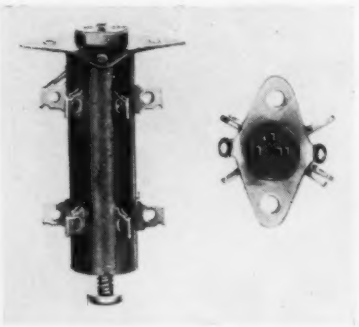
New Products . . . for the Electronic Industries

TRANSISTOR SOCKETS

A line of Transistor Socket Turrets, featuring a special transistor socket mounted in one end of a turret post are available. Two rings of 6 terminals each are placed at either end of the turret post. Socket tabs



extend directly over 3 terminals of the top ring. Components can be connected quickly and neatly between the 2 rings of turret post terminals and the transistor socket tabs may be soldered to adjacent turret terminals to complete the circuit. The socket is a dual purpose type. Contacts are beryllium copper, plated with gold over silver. Vector Electronic Co., 1100 Flower St., Glendale 1, Calif.

Circle 219 on Inquiry Card, page 97

DECADE BOX

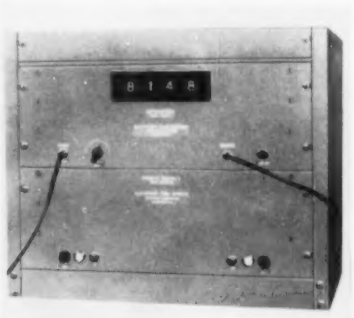
The power resistor decade box handles power. It is rated at 225 w. at 1000 v. maximum. Provides for any required ohmage from 1 to 999,999 ohms in increments of 1 ohm. Either known or unknown resistance value

is dialed and then read directly from the 6 decade dials. When accurate and predetermined steps of resistance value are desired, such as in calibrating or testing operations, for bridge circuits or for experimental setups, especially in working circuits, it provides a ready means of obtaining exactly the desired value under actual load conditions. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 221 on Inquiry Card, page 97

ELECTRONIC COUNTER

The O-P-T-I-Meter (Occurrences Per Time Interval Meter) is a 4 decade instrument which counts, samples, stores, and provides a working output without the need to stop the count in order to sample, and with no loss of

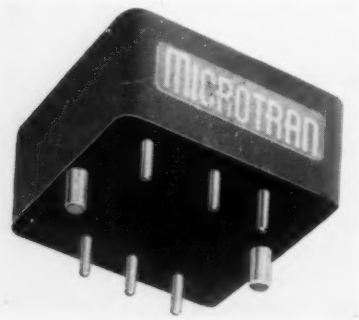


time between samples. Information is transferred from the counter to a storage output in less than 50 μsec, while the counter resets automatically to accept the next sample. The storage output continuously displays the last count sampled. Provisions have been made for relays, "Nixie" numerical indicators, and printers. Electronic Tube Div., Burroughs Corp., Plainfield, N. J.

Circle 223 on Inquiry Card, page 97

MOLDED TRANSFORMERS

A new line of micro-miniature size molded transformers have been introduced. Designed for transistor, audio and servo applications, these transformers are molded of high temperature epoxy to provide protection against extremes in ambient. Weighing ⅓ oz., the dimensions of this "MM-M" series is ¾ x ⅞ x ½ in. Mounting is by means of standard

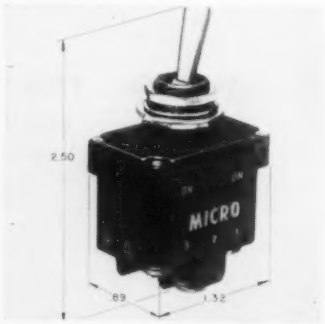


channel ears, threaded studs, or inserts. Terminal pins are arranged for use with dip soldered printed circuitry. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.

Circle 220 on Inquiry Card, page 97

TOGGLE SWITCHES

A new series of toggle switches designed for long-lasting life on aircraft, computer panels, and railroads featuring integral terminals, high impact strength and improved sealing has been developed. Integral terminal construction and a new step-design case offer ease of wiring and stronger terminals. Available with all types of standard contact arrange-

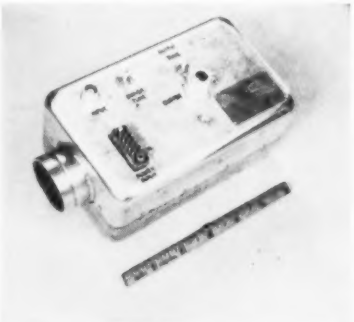


ments. Series of "TL" toggle switches include single-pole and two and four-pole circuitry models rated at 20 a., 30 vdc, resistive load. Micro-Switch, Freeport, Ill.

Circle 222 on Inquiry Card, page 97

TELEMETERING AMPLIFIER

The new small and rugged 100 watt telemetering amplifier requires only 2 watts drive. Measuring 3¼ x 4 x 6½ in. this new r-f amplifier covers the range 215 to 260 mcs. and operates under all missile vibration, acceleration and heat conditions. A built in blower allows operation at temperatures up to 125°C. The Model 1466 r-f amplifier, may be driven by



such 2 watt transmitters as the Model 1472-A FM/FM or PDM/FM telemetering transmitters. Telechrome Manufacturing Corp., 28 Ranick Drive, Amityville, N. Y.

Circle 224 on Inquiry Card, page 97

DOW CORNING CORPORATION

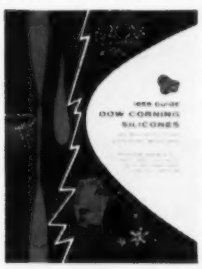
Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 16

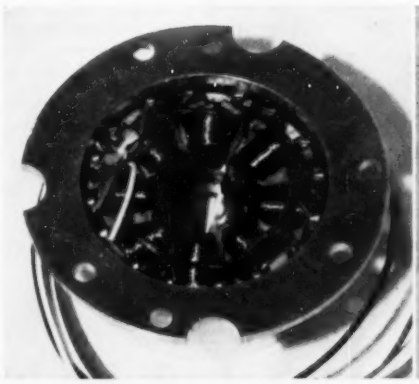
New Reference Guide To Aid You

Most complete reference guide to silicones ever produced, describes Dow Corning silicone products now available in commercial quantities: fluids, lubricants, resins, adhesives, varnishes, dielectrics, rubber, water repellents, textile finishes, leather treatments, and other specialized forms.

Its 16 pages are filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones.



Cross-indexed for handy reference, this all-new 1958 Guide includes properties and uses for the many new silicone dielectrics developed in recent months. A "must" for every design reference file, you can obtain your Free Copy by circling . . . . *No. 62*



SILICONE DIELECTRICS AID MINIATURIZATION

Silicone dielectrics help designers reduce the size and weight of miniature motors while increasing their dependability. Case in point: the new Servo motors produced by the Aeronautical Division of Minneapolis-Honeywell.

Containing what is believed to be the smallest stator coils ever wound for an ac motor, this entire motor is no larger than a golf ball. It weighs a mere 2 ounces, operates at controlled speeds ranging from zero to 11,000 rpm and develops a stall-torque of 0.75 ounce-inches.

Despite their miniature size, the motors withstand operational temperatures of 500 F and higher because they are fully insulated with heat-stable Dow Corning Silicones. Wound on bobbins, the tiny stator coils are held in place and insulated from the frame by terminal supports molded from Dow Corning 301 Molding Compound to assure adequate mechanical strength.

The miniature Servo motors drive calibrators, synchros, indicators and other assemblies for Honeywell's fuel measurement, automatic flight control and other aircraft instrument and engine control systems. They present a "Tom Thumb" illustration of the adage, "Dow Corning Silicones give motors more muscles . . . more power per pound." *No. 63*

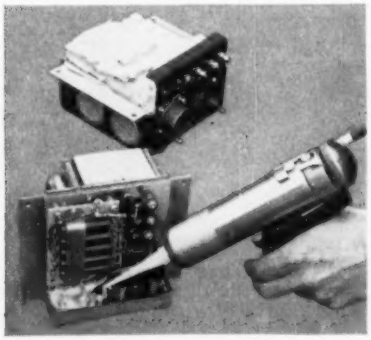
New "Shape-it-yourself" Silastic Vulcanizes at Room Temperature

A new, room temperature vulcanizing silicone rubber with excellent handling characteristics and durability is now available from Dow Corning.

The new rubber, Silastic* RTV 501, stays rubbery from —70 to 500 F and has exceptional resistance to moisture and weather. These and the other properties shown below make Silastic RTV 501 ideal for encapsulating electric and electronic assemblies and for general potting, sealing and calking applications.

*T. M. REG. U. S. PAT. OFF.

Typical Properties of Silastic RTV 501	
Serviceable temperature range	—70 to 500 F
Electric strength, volts/mil	300 to 500
Dielectric constant, 10^2 cycles per second	2.6
Dissipation factor, 10^2 cycles per second	0.01
Water absorption after 70 hours at 212 F, percent	Nil



Easy to process, the new silicone rubber has a long shelf life and mixes easily with the recommended catalyst. The two ingredients can be blended either manually or mechanically as long as three hours before being used. Both the fluid polymer and catalyst have a viscosity of approximately 60,000 centistokes. Silastic RTV 501 cures at room temperatures within 24 hours and attains maximum physical properties in only 2 to 3 days. *No. 64*

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Midland, Michigan
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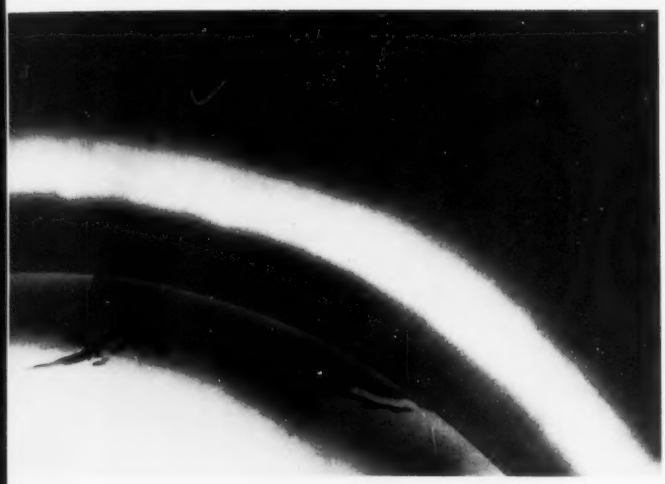
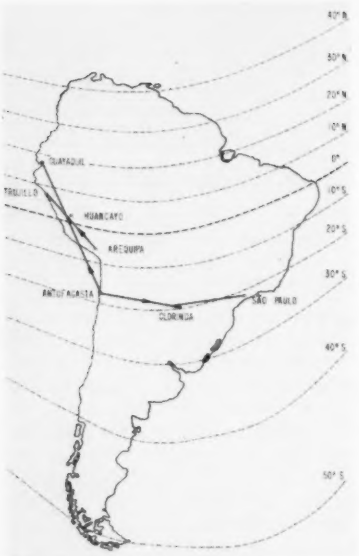
Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris



◀A sea of ions surrounds the earth. Our National Bureau of Standards is making a concentrated study of this "ionosphere" as part of the U. S. contribution to the International Geophysical year.

▲At NBS Boulder Labs, this IBM 650 will be used to process worldwide data to gain new information about the ionosphere. Here, left to right, are Kenneth A. Norton, Robert Doherty, and Ralph J. Slutz, of NBS.

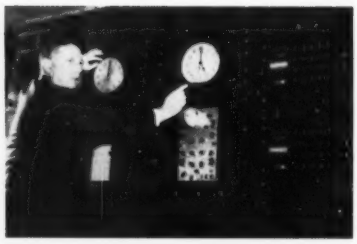
IGY Probes Ionosphere



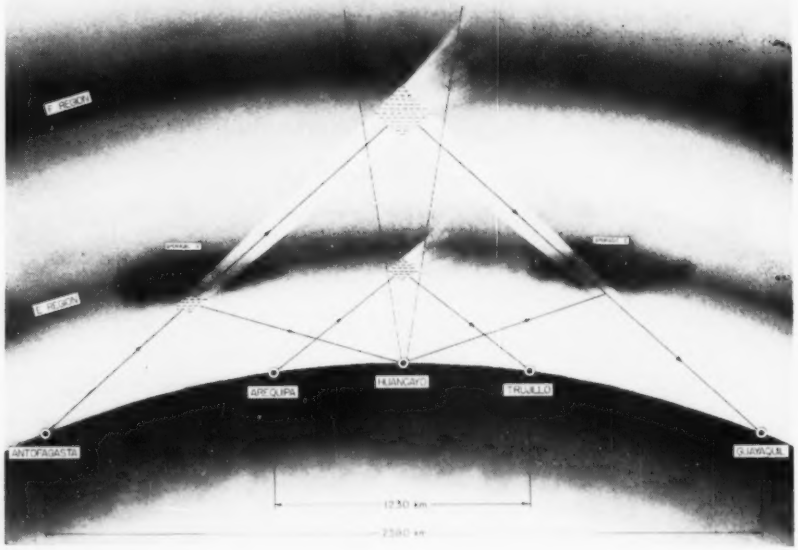
▲An experimental program to study ionospheric peculiarities near the equator has been organized by Boulder Labs.

One of the many antenna farms operated by NBS in North and South America in the IGY ▼Ionosphere study program.

Dr. Frederick W. Brown, director of the ▶ Boulder Laboratories, points to the nation's most accurate clocks, showing Universal and Mountain Standard Time. These clocks will time observations around the world.



This idealized drawing shows how radio energy scattered over long distances by irregularities in the ionosphere is being studied by stations in South American countries during ▼the 18-month IGY program.



THREE *steps forward in rectifier design by*

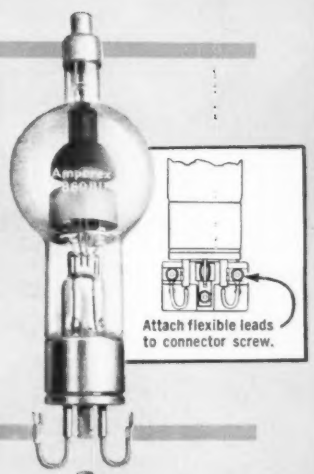
Amperex®

designers and manufacturers of the world's most complete line of rectifiers

1

THE NEW 7136 **single-anode, high-voltage mercury-vapor rectifier.** A plug-in replacement for the 575A, surpassing it in capacity and dependability, with higher peak inverse voltage. Offers trouble-free operation in induction and dielectric heaters.

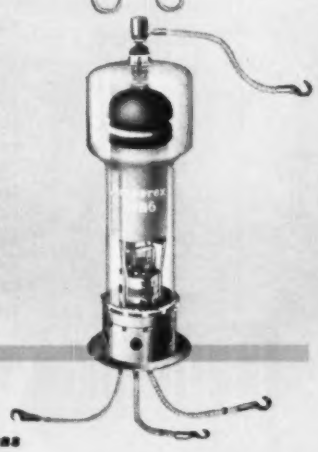
Peak Inverse Voltage: 15 kv
Average Anode Current: 3 amps



2

THE NEW 869 BL **heavy-duty mercury-vapor rectifier.** Uses short, flexible filament leads to eliminate possibility of high contact resistance. This prevents under-emission and tube damage, and insures proper voltage drop across the filament at all times. Preferred by equipment manufacturers and users for broadcasting, induction and dielectric heating equipment.

Peak Inverse Voltage: 15 kv
Average Anode Current: 5 amps



3

THE 6786 **super-power, grid-controlled, mercury-vapor rectifier.** Guarantees precise electronic control for industrial oscillators up to and **in excess of 100 kw output.** Proven long life in actual field tests.

Peak Inverse Voltage: 15 kv
Average Anode Current: 10 amps continuous;
15 amps intermittent

ask Amperex ***about mercury-vapor, inert gas and grid-controlled rectifiers for communications and industry***

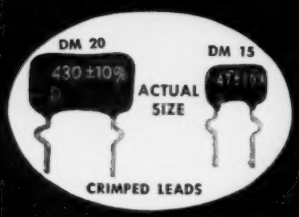
AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.
In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17, Ont.

Circle 49 on Inquiry Card, page 97

WEBSTER SAYS...

longevity (lon jev'i ti) *n.*
Great length of life.

DESIGN, DEVELOPMENT and PRODUCT ENGINEERS SAY:



El-Menco *Dur-Mica* CAPACITORS

Wherever your specifications call for long-lived miniaturized reservoirs, El-Menco Dur-Mica Capacitors offer ***PRE-PROVEN LIFE EXPECTANCY OF UP TO 20 YEARS*** . . . guarantee you confident, worry-free planning.

All these points make El-Menco *Dur-Micas* DM15, DM20, and DM30 the finest obtainable.

1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY — SILVERED MICA
5. PEAK PERFORMANCE

Extra-tough phenolic casings prolong life, increase stability over wide temperature range.

Recent comparison tests of El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors showed them to be longer-lived, more fatigue resistant than any others. Under stepped up conditions of 1½ times rated voltage at 125° C ambient temperature, each in turn achieved above standard ratings of undiminished performance well past 16,000 hours, or, under normal conditions, a projected working lifetime of from 15 to 20 years!

All environmental and electrical requirements of RETMA and MIL C-5 specs have been met. Test El-Menco Dur-Mica Capacitors for yourself with our help. Our engineering staff is at your service upon request.

write for Free samples and catalog on your firm's letterhead.

El-Menco *Capacitors*

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Manufacturers of El-Menco Capacitors
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• tubular paper • ceramic • silvered mica films • ceramic discs

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Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

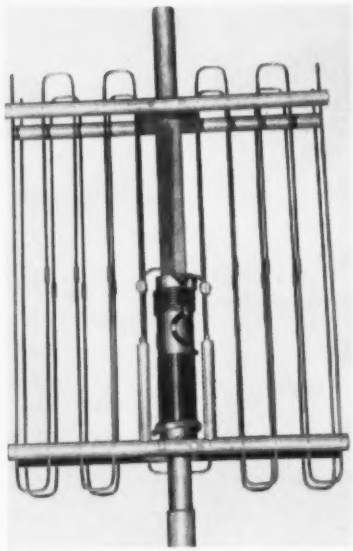
(*Continued from page 84*)

sub-bands are received or transmitted in the same frequency range, each antenna can serve both equipments at the same time.

A new "cyclic" switching component provides alternating connection of the ATC beacon with each antenna at a rate of about 50 cycles per second. Thus the ATC equipment is never out of contact with either antenna for more than 1/100 of a second and is in continuous operation for areas where the upper and lower antenna patterns overlap.

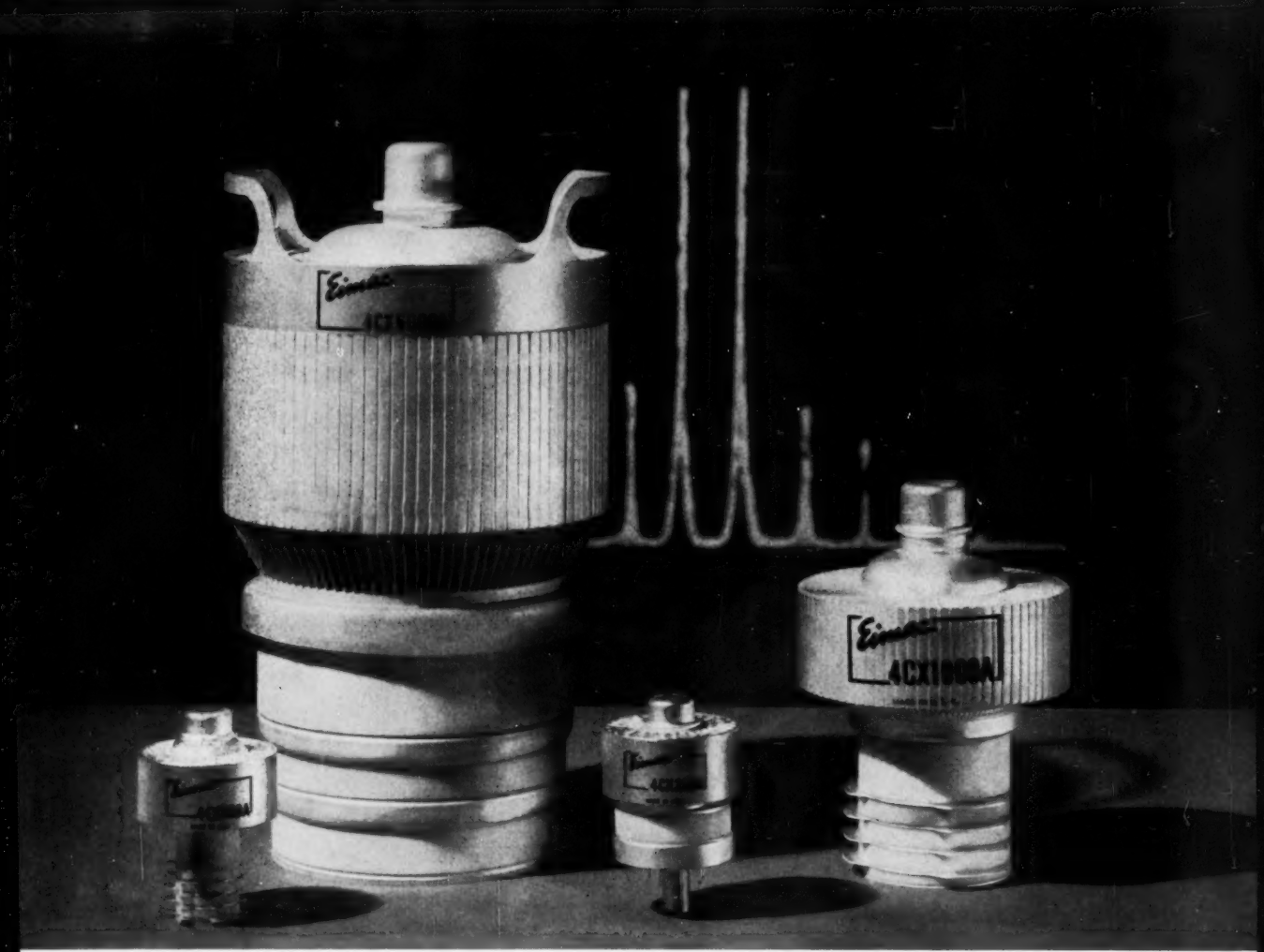
For TACAN, the incoming signal controls the connection of the system to the antenna, picking up the stronger signal by means of a "diversity" switching accessory unit. When a change in aircraft position or attitude causes the signal strength to drop below a certain point, the connection is automatically switched to the other antenna. Antenna selection for the outgoing TACAN signal is controlled by the incoming signal.

"Pleated" Dipole Antenna



A new series of "miniaturized" antennas for high-frequency communications bands has recently been introduced by the Freeman Co., in Yankton, S. D. The tiny unit, only 27" x 22" high, shows favorable gain over a half-wave dipole doublet, and has a 2 db front-to-back ratio. Unique advantage of the small beam antenna is that it can be quickly and simply mounted in small space on standard TV antenna mounts.

Circle 50 on Inquiry Card, page 97
Circle 51 on Inquiry Card, page 97 ⟶



The Ideal Approach to SSB...

Eimac Ceramic Tetrodes from 325 to 11,000 watts

Generating a clean SSB signal is one thing . . . amplifying it to the desired power level with stability and no distortion is another. A modern Class AB_1 final amplifier designed around an Eimac ceramic-metal tetrode is the ideal answer to the problem. The Eimac ceramic linear amplifier tubes shown above — the 4CX250B, the 4CX300A, the 4CX1000A and the 4CX5000A — offer the high power gain, low distortion and high stability that is needed for Class AB_1 operation. Each has performance-proved reserve ability to handle the high peak powers encountered in SSB operation. Efficient integral-finned anode cooler and Eimac Air System Sockets keep blower requirements at a minimum and allow compact equipment design. And, all four incorporate the many advantages of Eimac ceramic-metal design, which assures compact, rugged, high performance tubes.

The high performance and reliability of Eimac ceramic tetrodes make them the logical starting point in the design of compact, efficient single sideband equipment.

Write our Application Engineering Department for a copy of the technical bulletin "Single Sideband"

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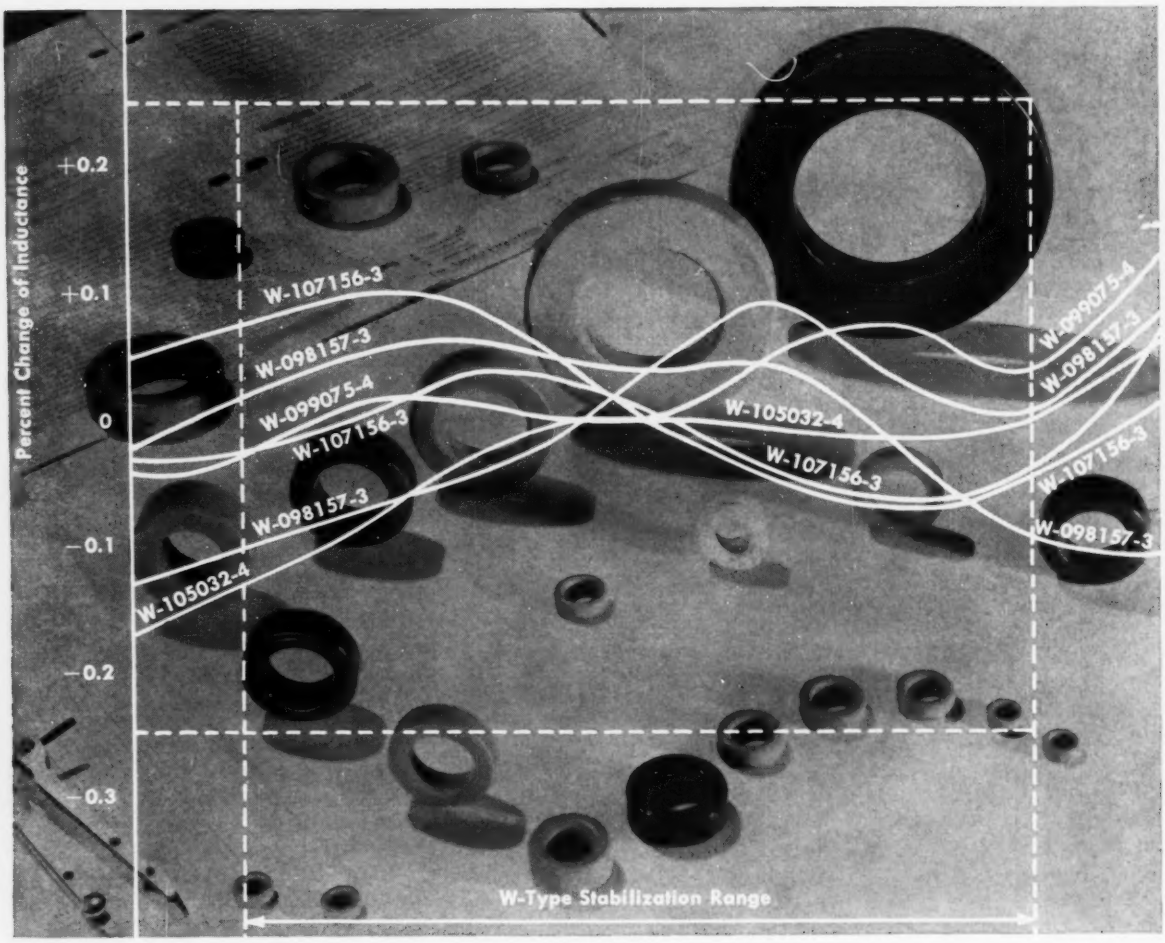
***Eimac First* with ceramic tubes that can take it**

Eimac®

CLASS AB_1 SSB OPERATION

	4CX250B	4CX300A	4CX1000A	4CX5000A
Plate Voltage	2000 v	2500 v	3000 v	7500 v
Driving Power	0 w	0 w	0 w	0 w
Peak Envelope Power . .	325 w	400 w	1680 w	11,000 w



ARNOLD offers you the widest selection of Temperature Stabilized MO-PERMALLOY POWDER CORES

Arnold Molybdenum Permalloy powder cores are available with the temperature coefficient of inductance controlled within certain limits over specific temperature ranges. Most core sizes and permeability combinations can be supplied in at least one of the four different types of temperature stabilization available.

For example, most of the popular core sizes are manufactured in the new type of wide range—"W"—stabilized cores whose temperature coefficient of inductance does not exceed 0.5% over the temperature range covered by the MIL-T-27 specification of −55° C to +85° C.

This type of guaranteed maximum change of inductance with temperature, as well as the constancy of permeability with time and flux level, are of particular importance to apparatus and circuit engineers. Many precision military and industrial applications demand the uniform performance and the excellent physical properties found only in Arnold Mo-Permalloy powder cores.

For design flexibility they are furnished in a full range of sizes, up to 5.218" O.D., in four standard permeabilities: 125, 60, 26 and 14. You will find them dependable and easy to use. You will find most sizes and types in stock *now* for immediate shipment.

● Let us furnish your requirements for temperature stabilized Mo-Permalloy powder cores, or any magnetic materials you need, from the most complete line in the industry.

WSW 6999

For more information write for Bulletin PC-104B

Lists complete line of Mo-Permalloy Powder cores . . . available in 23 sizes from 0.500" O.D. to 5.218" O.D. Furnished also with various types of temperature stability from Type "A" unstabilized to Type "W" stabilized over the temperature range of −65° F to +185° F.

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Smooth, uniform surfaces. Precision tolerances. Flatnesses within light bands are possible on many parts; so are faces parallel within .0005". Complete production facilities for speedy shipment in any quantity. Prototypes for test if you wish.

The industry's widest choice of special-purpose ceramic materials. Send blueprint or sketch with details of operation for complete data on the AlSiMag Alumina best suited for your purpose.

RATE HIGH AS: Bearings • Communication Parts • Compass and Gyroscope Parts • Cylinders • High Temperature Metalized Seals • Heliarc Welding Tips • High Speed Motor Parts • Instrument Parts • Jet Engine Parts • Machine Parts • Measurement Devices • Missile Parts • Pistons • Pump Liners, Seals and Plungers • Radomes • Rollers • Rotary Seals • Welding Jigs

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When Precision Counts...

CIRCON INSTRUMENT SCREWS

★ Precision from Head to Thread Stainless Steel or Brass
★ Plated Ready for Use
★ Largest Stock of Miniature Hardware
★ Immediate Shipment

Check These Dimensions on Fillister Head Screws

SIZE	Threads Per Inch	Major Diam.	Pitch Diam.	Minor Diam.	Pitch	Depth of Thread
000	120	0.034	0.0286	0.0260	0.00833	0.00400
00	90	0.047	0.0403	0.0326	0.01111	0.00721
0	80	.060	.0519	.0438	.01250	.00812
1	72	.073	.0640	.0550	.01389	.00902
2	56	.086	.0744	.0628	.01786	.01160
3	48	.099	.0855	.0719	.02083	.01353
4	40	.112	.0958	.0795	.02500	.01624

SIZE	Head Diam.	Height of Head	Depth of Slot	Width of Slot	Tap Drill	Body Drill
000	.056	.031	.014	012	#71 (.026)	#63 (.037)
00	.068	.038	.014	.023	#65 (.035)	#55 (.052)
0	.090	.050	.022	.025	3/64 (.047)	#51 (.067)
1	.111	.062	.024	.027	#53 (.059)	#47 (.078)
2	.132	.073	.029	.030	#50 (.070)	#42 (.093)
3	.153	.084	.035	.032	#47 (.078)	#37 (.104)
4	.174	.096	.040	.034	#43 (.089)	#31 (.120)

All Tolerances are per AN and MIL Specs. OR BETTER

We solicit your special and non-standard requirements

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Goleta, California
Telephone: Woodland 7-1113

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Integrating

(*Continued from page* 55)

The voltage on the capacitor is

$$e_c = \frac{1}{C}\int i\,dt = e_i + e_o = e_o\left(1 + \frac{1}{A}\right).$$

The input current is given by

$$i = \frac{e_s - e_i + \epsilon}{R} = \frac{e_s - \dfrac{e_o}{A} + \epsilon}{R},$$

so that

$$e_o\left(1 + \frac{1}{A}\right) = \frac{1}{RC}\int\left(e_s - \frac{e_o}{A} + \epsilon\right) dt;$$

expanding this, we obtain

$$e_o\left(1 + \frac{1}{A}\right) =$$

$$\frac{1}{RC}\int e_s dt - \frac{1}{ARC}\int e_o dt + \frac{1}{RC}\int \epsilon dt$$

at the end of the period of integration. Then

$$E_oRC\left(1 + \frac{1}{A}\right) =$$

$$\int_o^T e_s dt - \frac{1}{A}\int_o^T e_o dt + \int_o^T \epsilon dt.$$

Presuming that e_o increases fairly uniformly with time, i.e., $e_o = \dfrac{E_o t}{T}$ and presuming than ϵ does not drift during the cycle, we have

$$\int_o^T e_s dt = E_oRC + \frac{E_oRC}{A} + \frac{E_oT}{2A} - \epsilon T;$$

since we wish to have

$$E_oRC = \int_o^T e_s dt,$$

then the last 3 terms of the abovetequation are errors and should be much less than E_oRC.

Therefore, for satisfactory operation we must fulfill the following 3 requirements:

1. $E_oRC >> \dfrac{E_oRC}{A}$
2. $E_oRC >> \dfrac{E_oT}{2A}$,
3. $E_oRC >> \epsilon T$.

Reducing these, we have

1. $A >> 1$,
2. $ARC >> T$;

since $E_o = \dfrac{E_sT}{RC}$, then $T = \dfrac{E_o}{E_s}RC$;

therefore we must have $A >> \dfrac{E_o}{E_s}$;

3. $\dfrac{E_o}{\epsilon}RC >> T$.

These are the necessary conditions for operation, and the errors are summarized as follows:

1. Per unit error due to insufficient gain $= \dfrac{1}{A}$.

2. Per unit error due to low input voltage or impedance

$$= \frac{E_o}{2AE_s} = \frac{T}{2ARC}.$$

3. Error due to inaccuracy and drift in the zero set $= \dfrac{\epsilon}{E_o}\dfrac{T}{RC}$.

Since R is essentially infinite when a current source is used, the last 2 errors are zero for ion chambers or equivalent sources.

Conclusions

For satisfactory operation of a dc feedback amplifier of this type as an integrator from a voltage source, the following conditions are necessary:

1. The gain must be as high as possible and at least equal to the inverse of the expected error.

2. The average applied voltage times the amplifier gain must be much greater than the ultimate output voltage of the unit. This is because the input to the amplifier rises and cancels out part of the input voltage as the integration proceeds. In some cases when pulses are integrated the pulses may be well above the required voltage, but owing to the low-duty cycle the average voltage may be much too low. The result is that a large error is produced by leakage back through the source.

3. The voltage due to the error in zero setting tends to charge the capacitor indefinitely when a return path to ground is provided by a grounded source. If the source impedance is high enough so that the total charge collected during the integration period is negligible then it can be neglected. If, however, a low impedance is placed across the input the error signal charging may be an appreciable part of the total output.

This work was done under the auspices of the U. S. Atomic Energy Commission.

* * *

New RCA transistorized microphone provides high fidelity response with an output comparable to carbon microphones. It uses three A-B composition resistors.

RCA uses *Reliable* ALLEN-BRADLEY RESISTORS

The reliability of your product is no better than the reliability of the components you use. That's why it is sound design procedure to specify Allen-Bradley hot molded resistors. They are recognized by electronic engineers throughout the world for their conservative ratings and stable characteristics. The solid molded insulating jacket assures superior humidity resistance after subjection to high humidity for long periods of time . . . as normally encountered in actual practice. These resistors *cannot* "open circuit."

You cannot go wrong with Allen-Bradley *quality* components—composition resistors; ceramic capacitors, and ferrite parts. Write for technical information, today.

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In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

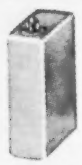
Circle 55 on Inquiry Card, page 97

For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS

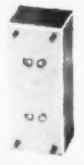
All types for frequencies from .1 cycle to 400 MC.



400 ∽ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ∽, ⅝ x 1¼ x 2".

15 ∽ BP filter, 20 db at 30 ∽, 45 db at 100 ∽, phase angle at CF less than 3° from —40 to + 100° C.

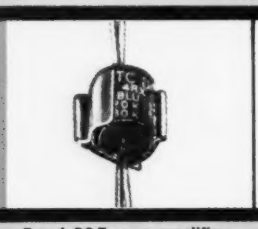
LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.



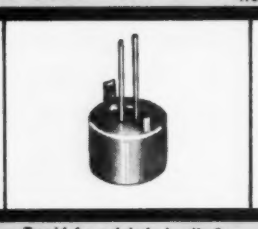
LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.

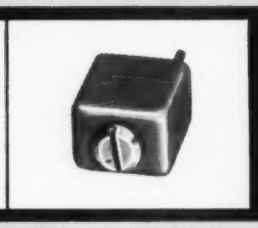


Tuned DO-T servo amplifier transformer, 400 ∽ .5% distortion.



Toroid for printed circuit, Q of 90 at 15 KC.

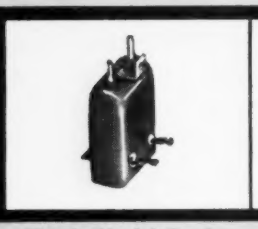
Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.



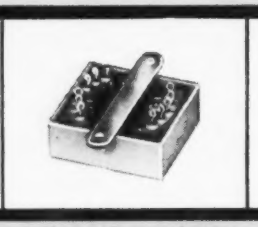
HVC tapped variable inductor for 3 KC oscillator.

SPECIALTIES

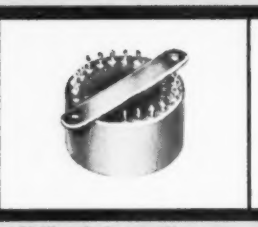
Saturable reactors, reference transformers, magnetic amplifiers, combined units.



RF saturable inductor for sweep from 17 MC to 21 MC.



Voltage reference transformer .05% accuracy.

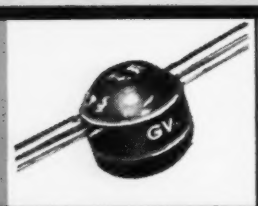


Multi-control magnetic amplifier for airborne servo.

Input, output, two tuned interstages, peaking network, and BP filter, all in one case.

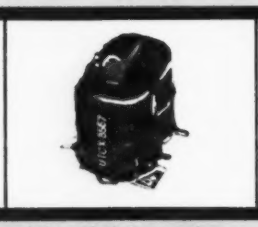
PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.



Wound core unit .01 microsecond rise time.

Pulse current tansformer 100 Amp.

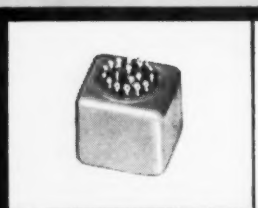


Pulse output to magnatron, bifilar filament.

Precise wave shape pulse output, 2500 V. 3 Amps.

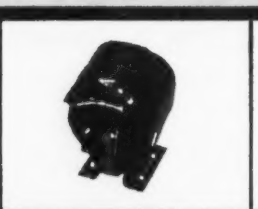
POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.



Multi-winding 140 VA, 6 KC power transformer 1¼ x 1¼ x 1"

200° C. power transformer, 400 ∽, 150 VA.



400 ∽ scope transformer, 20 KV output.

60 ∽ current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

UNITED TRANSFORMER CORPORATION

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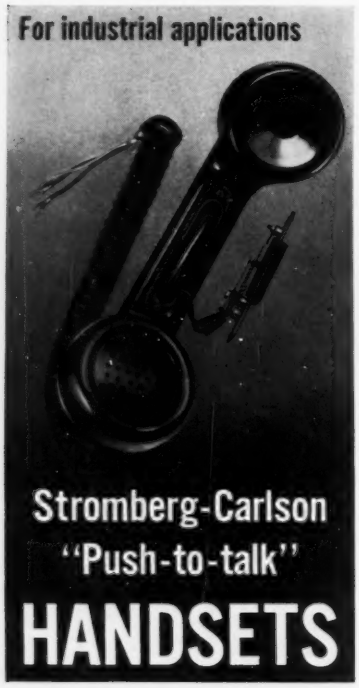
METUCHEN, NEW JERSEY

Circle 57 on Inquiry Card, page 97



You'll find many valuable uses for Stromberg-Carlson's "Push-to-talk" telephone handsets in your day-to-day operations. These instruments feature switch assemblies with various spring combinations mounted in the handles, actuated by a rocker-bar lever. A few typical applications:

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- **Push-to-open** and **Push-to-close external circuit:** for use with dictating machines and in remote control operations.

You have a choice of two types of handset: No. 28, which is the standard model; and No. 29, a special high-gain, high-efficiency handset with Western Electric type receiver and transmitter. Available with either coiled or straight cord.

For complete technical details on these handsets and other Stromberg-Carlson telephones and components for industrial use, send for Bulletin T-5005. Write to:

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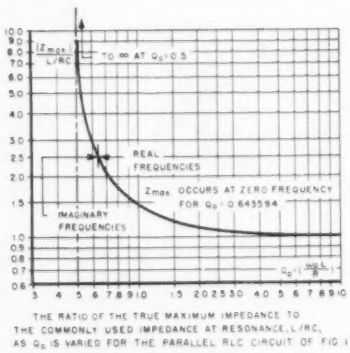
Low-Q

(*Continued from page* 73)

Since ω_c changes with Q_0, the essential character of the graph is changed to emphasize the change in maximum input impedance with respect to the impedance of the circuit operating at unity power factor for values of Q_0. Fig. 7 is, again, similar to Fig. 5, except here the ratio of the input impedance to the impedance of the circuit operating at ω_0 changes for each Q_0, because Z_0 is a function of Q_0. This is essentially useful in pointing out that this ratio becomes "larger" for the "smaller" Q_0 for any value of "a". Fig. 8 is, again, similar to Fig. 5, except that here the frequency is normalized with respect to ω_m, and the input impedance is normalized with respect to the maximum input impedance, Z_m. Since both ω_m and Z_m change with Q_0, then, again, the essential character of the graph has changed to emphasize the fact that the ratio, $\frac{Z}{Z_{max}}$, is larger for smaller values of Q_0.

Figs. 5, 6, 7, and 8 are useful curves for finding the behavior of the circuit in the vicinity of any one of its resonant frequencies for varied Q_0. Fig. 4 helps emphasize



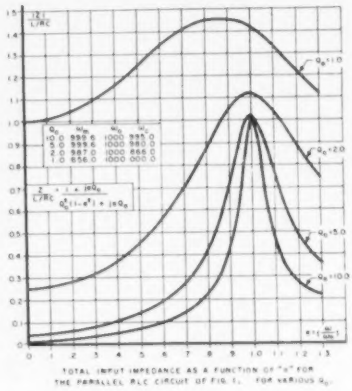
THE RATIO OF THE TRUE MAXIMUM IMPEDANCE TO THE COMMONLY USED IMPEDANCE AT RESONANCE, L/RC, AS Q_0 IS VARIED FOR THE PARALLEL RLC CIRCUIT OF FIG. 1

Fig. 7: Ratio of true maximum to commonly used impedance at resonance.

the fact that there is not always a real frequency for which the input impedance will maximize. This may be observed, also, in Fig. 3.

Design Procedure

For a given application and in their order of importance, a listing should be made of the types of resonant frequencies. Next, if Q_0 of the circuit is specified, then the resonant frequencies are read from Fig. 3 or obtained with the aid of Table I. Next, the input impedances are checked at each of these resonant frequencies by using Table I, or in the case of maximum input impedance, Fig. 4 may be used. Next, the variation of the input impedance as the frequency changes around each type of reso-



TOTAL INPUT IMPEDANCE AS A FUNCTION OF "a" FOR THE PARALLEL RLC CIRCUIT OF FIG. 1, FOR VARIOUS Q_0

Fig. 8: Plot of total input impedance.

nant frequency is checked in Figs. 5, 6, 7, and 8 for the particular Q_0 of interest.

If the Q_0 given is close to a Q_0 plotted in Fig. 5, then the variation of input impedance with frequency around ω_0 may be checked directly here. If the given Q_0 is not reasonably close to a Q_0 plotted in Fig. 5, then Fig. 7 is a more convenient graph for interpolating for the input impedance; because here the general shape of each Q_0 plot is more nearly uniform near ω_0. One additional step is required to be able to use Fig. 7, that is the calculation of Z_0. The variation of the input impedance with frequency around ω_c and ω_m can be checked quickly by using Figs. 6 and 8, respectively. The general shape of these curves for varied Q_0 are similar; so interpolation for a given Q_0 curve is not too difficult.

(*To be continued next month*)

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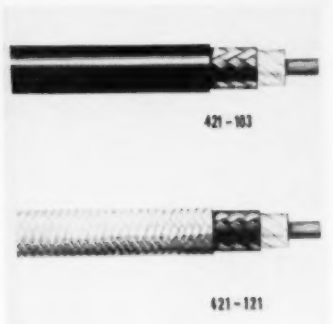
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila., Pa.

New Products

COAXIAL CABLES

Two Teflon tape dielectric coaxial cables electrically equivalent to RG-117/U, part numbers 421-103 (vinyl jacket) and 421-121 (Fiberglas jacket) are available. Cables are similar except for jackets, with an im-

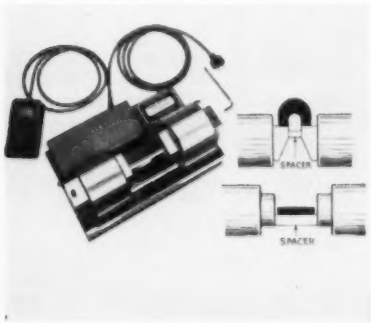


pedance of 50 ohms, dielectric strength of 10,000 v. RMS and a maximum attenuation of 3.0 db/100 ft. at 400 MC. Temperature range for the 421-103 is −55°C. to +85°C.; −100°C. to +200°C. for the 421-121. Cables provide improved flexibility by the combination of a multi-strand center conductor and the Teflon tape dielectric. Amphenol Electronics Corp., 1830 S. 54th Ave., Chicago 50.

Circle 225 on Inquiry Card, page 97

MAGNETIZERS

Two new, completely self-contained magnetizers that can be plugged into any 115 vac outlet are available. Magnetizing coils and silicon rectifier are combined in one unit in both the light-duty Model MF-200 and medium-duty Model MF-300 magnetizers. No permanent, rigid installation is needed. They are small and light enough to be readily moved. A convenient foot switch and pole pieces—round pole

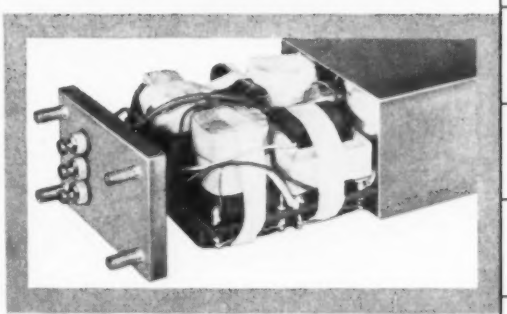


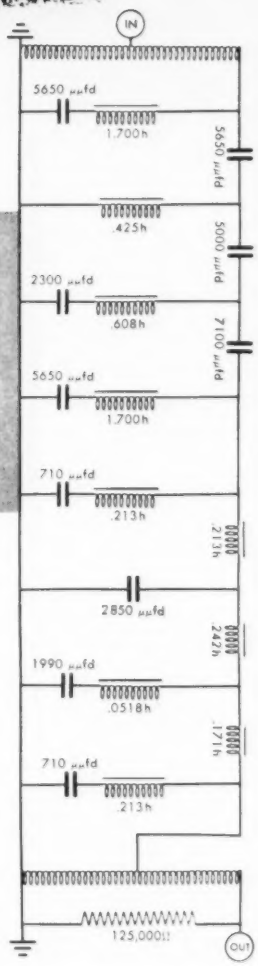
pieces for use with bar magnets and tapered for horseshoe magnets—are included. General Electric Co., Magnetic Materials Div., Edmore, Mich.

Circle 226 on Inquiry Card, page 97

WHAT GOES INTO A CHICAGO STANDARD FILTER?

capacitors...
inductors...and
ENGINEERING!





This schematic is typical of the thousands of complex filters regularly designed and built by Chicago Standard engineers . . . engineers who have the highly specialized knowledge and experience, in both mechanical and electrical design, that is essential to good filter production.

Using both toroidal *and* laminated inductors, they design compact, efficient and reliable units, with high Q and low loss. For

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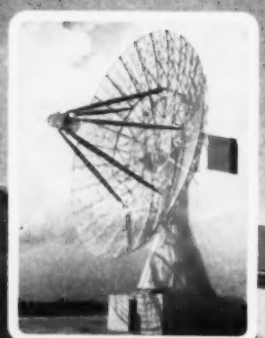
Circle 59 on Inquiry Card, page 97

Big dish with a big job...

NEW 84′ KENNEDY TRACKING ANTENNA

28′ RADAR TRACKING ANTENNA



60′ TELEMETRY TRACKING ANTENNA

TOWERING 90 feet above the New England countryside at Westford, Mass., this giant 84′ tracking antenna is part of a new, long-range radar installation now studying problems in ballistics missile defense.

Equipped with an elevation-azimuth type mount designed and fabricated in cooperation with M. I. T.'s Lincoln Laboratory, the big dish can make a full 360° horizontal sweep and has a vertical rotating capability of 90°. Like all Kennedy steerable antennas, it features a light weight, aluminum dish supported by a steel pedestal mounted on a concrete base.

This kind of achievement in antenna design and construction is solid proof that Kennedy is the name to remember when you are faced with antenna problems.

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ANTENNA EQUIPMENT

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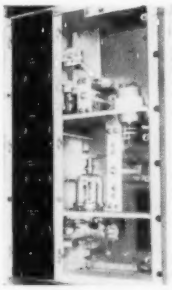


Low Power TV Transmitter 02

Describing an inexpensive, low power VHF transmitter that can find application as a VHF satellite, in small market service in conjunction with a re-broadcast receiver, and as a driver.

Transistor Mike Booster 06

A single-stage transistorized unit, self-powered and conservatively rated at one year, is easily inserted into the line when the microphone must be located at awkward distances.

SYSTEMS—WISE . . .

FOR MISSILE CONTROL

The Army Air Defense Command last month began operation of their Missile Master System at Ft. Meade, Md. System coordinates the firing of anti-aircraft missiles around Wash., D. C.

▸ **The last figures are finally in for AM broadcast operations during 1956. A total of 849 (29.3%) of the nation's AM radio stations reported a loss from operations during 1956. In 1955, the comparable per cent of losing AM stations was 27.5%. Preliminary returns from 1957 show a heartening improvement. Write on company letterhead for a report on broadcast income and expenses for 1956.**

▸ **Mutual is going over to FM links with some of its rural AM affiliates, not now serviced by high-fidelity A.T.&T. lines. Mutual president, Paul Roberts says the new system will permit expansion from about 460 affiliates to over 600.**

▸ Out of 49 million American homes, 43 million have at least one radio . . . The typical American home plays one or more radios more than two hours a day .

▸ **Tighter Federal regulation of TV networks will be aired by the FCC, in hearings starting March 3.**

▸ NAB president Harold E. Fellows has urged Congress again to decide the issue of pay television. Mr. Fellows hailed the recent statement by Rep. Harris (D-Ark) in which he said, ". . . the principle of so-called pay-TV would be against the best interest of the American public."

▸ **"Free Television—How It Serves America," is the name of a new 24-page booklet put out by NAB. This explanation of the history and value of free TV is available at 25 cents from NAB, 1771 N Street, N.W., Washington 6, D. C.**

▸ American Citizens Television Committee, Inc. (ACT), has set up offices at 1010 Vermont Avenue, N. W., Washington 5, D. C. The group will lobby against Pay TV.

▸ **Don't lie for FCC radio operator permits! Herb Weichmann claimed birth in New Jersey when he applied for Third Class Radiotelephone operator permit. FCC found he was born in Germany — also found an undisclosed criminal record. Weichmann drew sentence of two years in prison and $2,500 fine. Deportation as undesirable alien followed—the first such deportation in FCC history.**

VHF TV Transmitter for Low Power Operation

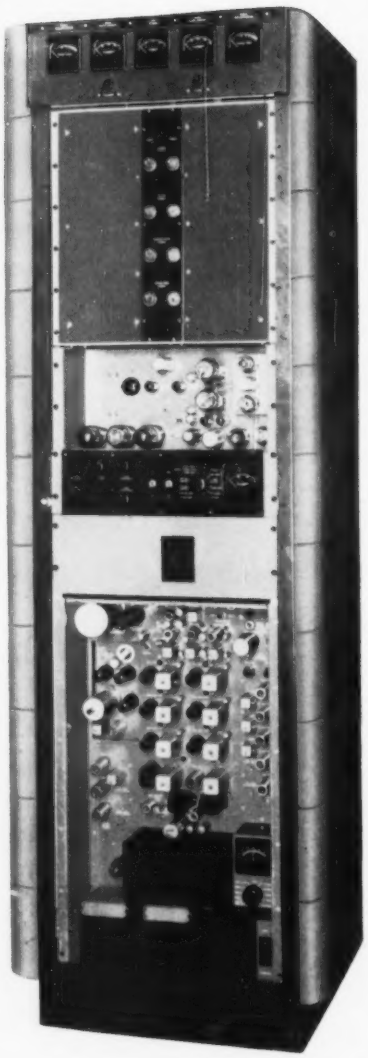
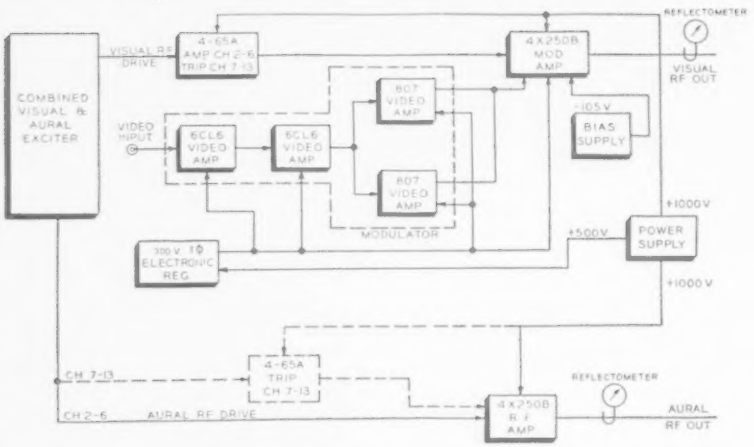


Fig. 1: A compact VHF transmitter that may be used for a driver unit.

The small TV transmitter described is designed to fill the need for inexpensive, low power VHF transmitting equipment. It will serve in such applications as VHF satellites, small market service in conjunction with a re-broadcast receiver and as a driver for a 500 watt linear amplifier.

By ROBERT S. JOSE
Broadcast Transmitter Design & Development Engineer
RCA, Camden 2, N. J.

Fig. 2: Block diagram shows the basic sub-divisions of the transmitter



THE small television transmitter described in this article was designed to fill the need for inexpensive low power VHF transmitting equipment. As such it will serve in such applications as VHF satellites, small market service with rebroadcast receiver and/or local origination video sources, and in standby service particularly when used in conjunction with, and as a driver for, the TTL-500AL/AH 500 watt linear amplifier. The TTL-100AL covers channels 2 to 6, the TTL-100AH—7 to 13.

The type designation represents a departure from the standard RCA

system to prevent ambiguity with the TT-100AH 100 KW transmitter. Admittedly this confusion could exist only on paper. Actually the transmitter will develop 120 watts peak visual power, 60 watts aural power.

The transmitter is self contained in one standard RCA type BR-84 cabinet. As a result of this feature, the transmitter can be installed alongside existing terminal facilities harmoniously. For other applications where the transmitter is installed as a separate unit, it can be operated unattended, having provision for remote or time clock ac power control.

The block diagram (Fig. 2) shows the basic subdivisions of the transmitter.

Exciter

The intercarrier exciter is identical with the unit described in an article by F. E. Talmage[1] and for further details, the reader is referred to that article. The exciter chassis is hinged at the bottom and can be tilted out of the cabinet to a horizontal position for servicing. The separate aural and visual outputs of the exciter are at respective carrier frequencies on channels 2 to 6 and ⅓ of carrier frequencies on channels 7 to 13.

RF Circuitry

The aural and visual exciter outputs are connected by coaxial cables to the enclosure near the top of the cabinet which contains the higher power r-f stages.

An interior view of this enclosure for the TTL-100AH is shown in Fig. 3, with the aural stages in the left hand compartment and the visual in the right. Each exciter output drives a 4-65A tripler (which is visible on the lower shelf in Fig. 3) and each tripler drives a 4X250B in the output stage. The visual 4X250B is grid modulated, the aural is a Class "C" amplifier. The coupling circuit between each 4-65A and 4X250B contains a variable capacity voltage divider (seen just below the 4X250B) which serves as a course r-f excitation adjustment.

The visual plate circuit is double tuned and capable of being adjusted for a 6 MC (to 1 db down) wide r-f bandwidth. This is greater than necessary for domestic use but because of the 4X250B characteristics causes no power reduction.

The lead between the modulator and modulated 4X250B grid contains an r-f trap. In the TTL-100AH this trap consists of a quarter wave stub "shorted" at the end opposite the grid by a capacitor. Looking toward the modulator from the grid, the r-f sees a high impedance. The stub is resonant at approximately channel 10, but is effective from channel 7 to 13 without adjustment.

The channel 2 to 6 r-f box version is very similar to channel 7 to 13 with the following exceptions. Since the exciter output is at carrier frequency, the visual 4-65A stage does not multiply. The aural 4-65A is omitted altogether since the aural exciter output is adequate to drive the 4X250B to 60 watts aural power. The coupling method in the wide-band plate circuits for the 4X250B's is different from the high channel version, but the bandwidth is the same. Finally the r-f grid trap is tuned to resonance on each channel by a variable capacitor.

Modulator

The modulator (Fig. 4) contains, in addition to the video stages and the electronic regulator for the video amplifier and r-f screen voltages, the metering and control circuits for the transmitter.

The output stage of the modulator consists of two 807's in parallel, direct coupled to the 4X250B grid thru a bucking bias supply. The bucking bias is obtained from two OD3's in series. The 807 grids are

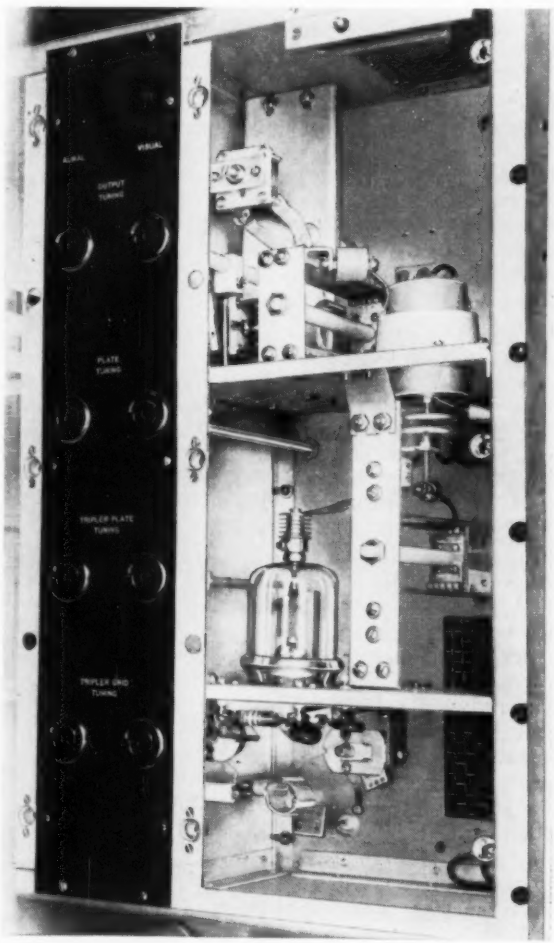


Fig. 3: Maintenance and servicing are easily accomplished

driven by two 6CL6's in cascade and clamped by means of a 1N34 diode. Both 6CL6 stages are series-shunt peaked and have sufficient gain to operate from a 1v.p. to p. input video signal.

The 807 stage is deliberately made about two or three times as large as would be required for monochrome transmission. This is done to achieve a lowered output impedance so that the grid current drawn by the 4X250B will not cause excessive differential phase shift. The 4X250B grid current at black level can,

(*Continued on page* 012)

[1] *Broadcast News*, Vol. No. 91, Pages 50-53, October 1956. (Copies may be obtained by writing on company stationery to Editor, ELECTRONIC INDUSTRIES.)

Linear Variable Phase Shifter

By William B. Conover
High Voltage Lab.
Power Transformer Dept.
General Electric Co.
Pittsfield, Mass.

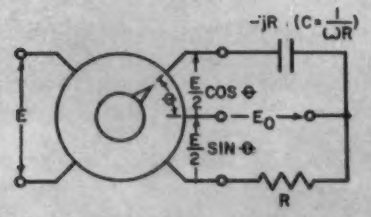


Fig. 1: A sine-cosine pot, a resistor, and a capacitor form a simple phase-shifter.

MANY measurement and control devices require a means for shifting the phase of an electrical signal by an easily adjustable amount. Various methods have been devised for accomplishing this, but they all leave something to be desired in either simplicity of construction or linearity of operation. The circuit described below is simple, it uses commercially available components, and it has the following operational features:

1) Phase shift in electrical degrees is equal to the control shaft angle in mechanical degrees.
2) Full phase shift from 0 to 360 degrees is obtainable.
3) The ratio of output to input voltage has constant amplitude.

The control element of the device is a sine-cosine potentiometer, of which there are two types commercially available: the card type and the tapered resistance type. In either type, a voltage applied to the input terminals gives two output voltages, one proportional to the sine of the potentiometer shaft angle, the other proportional to its cosine. The shaft continuously rotatable in either direction.

To construct a phase shifter for controlling the phase of a sine wave of voltage, a resistance and a capacitance are connected to the output terminals of the sine-cosine potentiometer as shown in Fig. 1. The reactance of the capacitor C at the desired frequency of operation should be chosen to equal the resistance R; i.e., $\frac{1}{\omega C} = R$. Referring to Fig. 1, the output voltages of the potentiometer are $\frac{E}{2}\cos\theta$ and $\frac{E}{2}\sin\theta$, where E is the input voltage and Θ is the angular setting of its control shaft. The output voltage E_o across the R-C network may be found by subtracting the voltage drop across the capacitor from the voltage applied to this half of the circuit. That is,

$$E_o = \frac{E}{2}\cos\theta + jRI \qquad (1)$$

but

$$I = \frac{\frac{E}{2}\cos\theta + \frac{E}{2}\sin\theta}{R(1-j)} \qquad (2)$$

Substituting (2) into (1) and rearranging, gives

$$\frac{E_o}{E} = \frac{1}{2}\left[\cos\theta + \frac{j}{1-j}(\cos\theta + \sin\theta)\right]$$

$$= \frac{1}{2(1-j)}(\cos\theta + j\sin\theta), \text{ or } \frac{E_o}{E}$$

$$= \frac{1+j}{4}(\cos\theta + j\sin\theta). \text{ Expressed in}$$

polar form, this is $\frac{E_o}{E} = \frac{\sqrt{2}}{4}(\theta + 45°)$

By absorbing the constant 45° in the calibration of the dial of the potentiometer shaft, the ratio of the output to input voltage is

$$\frac{E_o}{E} = 0.353\ \theta \qquad (3)$$

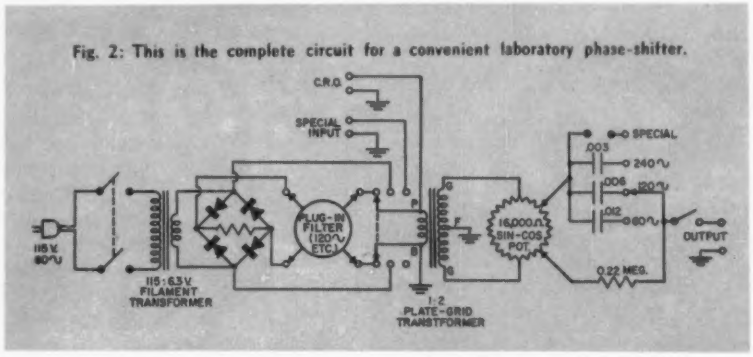
This shows that the output voltage is a constant 35.3 per cent of the input voltage, at a phase angle Θ (equal to the potentiometer shaft angle) with respect to it.

Accuracy

In the above analysis, it was tacitly assumed that the outputs of the potentiometers were accurately proportional to the sine and cosine of the shaft angle. Present commercial potentiometers depart from true sine and cosine functions by about ±1 per cent. In addition to these errors the loading effect of the R-C network and the output impedance must be considered. Although straightforward, calculations of loading error are quite tedious, since both amplitude and phase angle error depend not only on shaft angle, but on the ratios of R and the output impedance to the potentiometer resistance. The form of the circuit equations differs for the card-type and the tapered potentiometer. Therefore, where questions of high accuracy are involved, calculations of errors should be made for the particular circuit parameters to be employed. As an approximate guide, however, it may be said that the value of $R = \left(\frac{1}{\omega C}\right)$ should be 10 times the total resistance across the potentiometer for loading errors to be of the same order as the functional errors in the potentiometer.

(*Continued on page* 015)

Fig. 2: This is the complete circuit for a convenient laboratory phase-shifter.



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Circle 61 on Inquiry Card, page 97

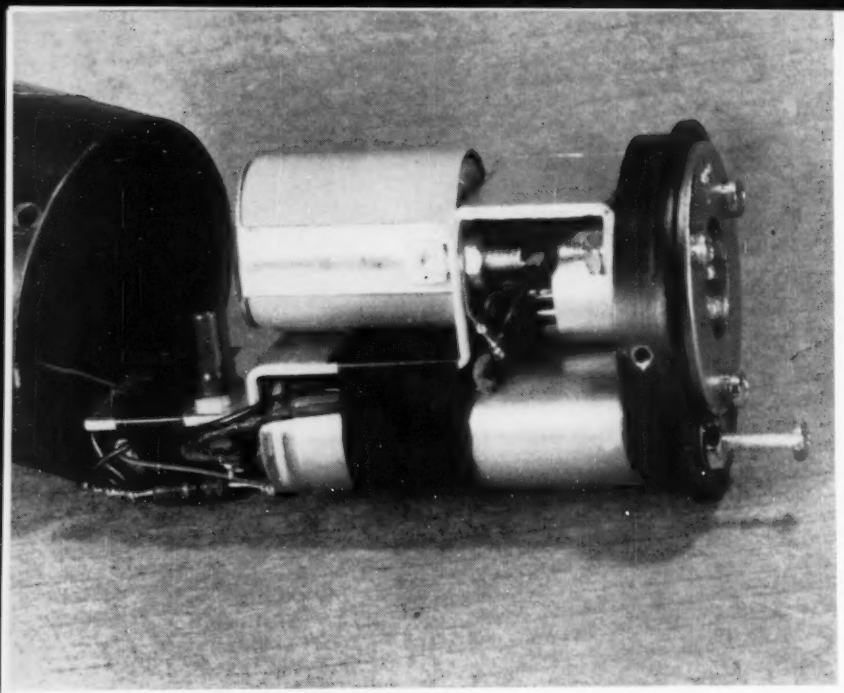


Fig. 1: The entire remote amplifier, except for the receptacles, is built on one bracket. At the top is the output transformer, and taped beneath are the mercury cells

By JOHN K. BIRCH
Audio Design Engineer
Gates Radio Co.
Quincy, Illinois

Designing a Transistor Mike Booster

A delicate balance between theory and practical considerations results in a useful transistorized booster for insertion into remote microphone lines. The single-stage transistorized unit contains its own power supply, conservatively rated at one year.

BROADCAST work often requires extra microphone channel gain, in addition to the standard console gain. This usually arises from an awkward mike placement, such as high over a stage, behind a church altar, or dangling from a boom for TV work.

In television, this wide separation, combined with a sound source having low output volume, often creates a serious problem. Usually the operator will run the mike control wide open and use the master control to achieve normal level, but this upsets all the other input controls on the board. A transistor booster amplifier in the mike line can eliminate this difficulty.

Three main features must be considered in the design of such an amplifier:

1. It must provide broadcast quality performance: low distortion and noise, wide frequency response, good temperature stability, and low output impedance.
2. It must have a gain of about 15 db.
3. It must be completely self-contained to eliminate additional wiring.

Circuit Design

We can picture the preliminary circuit from this information. It will consist of one stage, using the common-emitter configuration for maximum gain. It will need no input transformer, because the input impedance will be around 2000 to 3000 ohms; and since low-impedance microphones are designed to work into an input circuit which offers no load, this is an ideal condition. It will use mercury batteries for long service.

Finally, the output circuit will be transformer coupled, for three reasons:

1. To hold down I-R drop in the collector circuit and reduce the number of battery cells needed.
2. To drop the output impedance as low as usual mike impedance, and offer a choice of impedances with split windings.

3. To balance the output circuit, minimizing noise pickup problems where long lines are involved.

The most important obstacles to wide frequency response is the deficiency at the low end due to the ease with which a miniature core is saturated by a small amount of dc in the windings, placing a very definite limitation on minimum size. In this amplifier, the transformer is one inch in diameter by one and three-eighths inches long; amplifier response is down less than 3 db at 70 CPS.

To help this response, large coupling and emitter bypass capacitors are required; the values shown are the minimum which will have no effect on output level at 50 CPS At the high end, response is flat within 1 db up to 15 KC.

Output

Another important feature is the resistor, R_5. Without this resistor, there would be no load on the output transformer, since the console mike preamplifier into which it works has an unloaded input circuit. With no load on T_1, the booster gain would increase considerably—about 15 db—but there would be serious frequency discrimination. At the low end, response would be affected by the low inductance of the transformer, and at the high end by the high collector capacitance. For example, in this circuit with no load, the response peaks at 1 KC and is down 10 db at 200 and 10,000 CPS.

Distortion

Any discussion of transistor amplifier distortion must start by specifying operating levels. Due to the non-linear characteristic of the emitter-base diode, only extremely small signals can be handled with negligible distortion; that is, signals on the order of — 60 dbm. This value can be increased considerably by the use of either shunt feedback or emitter degeneration.

Degeneration is produced in this circuit by resistor R_3 similar to the way degeneration in a vacuum tube amplifier results from an unbypassed cathode resistor. This reduces the gain of the amplifier, and increases the maximum input level by a similar amount.

The effect of R_3 is illustrated in Fig. 4, in which harmonic distortion is plotted against input level for resistances of zero and 82 ohms. A value of 82 ohms for R_3 reduces the stage gain by 6 db. This extended input range is considered desirable, because the microphone with which the booster is used may be called on to handle a wide variety of sound sources without overloading.

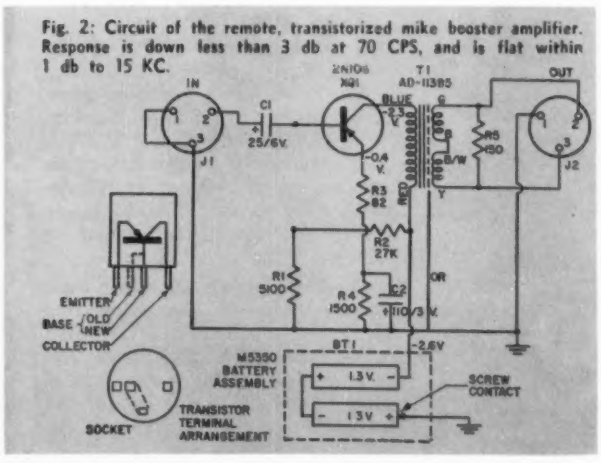


Fig. 2: Circuit of the remote, transistorized mike booster amplifier. Response is down less than 3 db at 70 CPS, and is flat within 1 db to 15 KC.

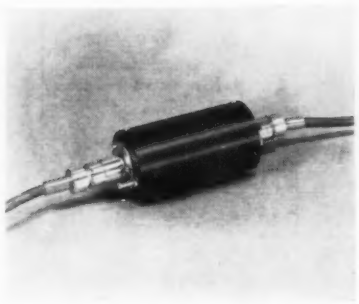


Fig. 3. Booster assembles into a can 2 inches in diameter by 3⅞ inches long. Cannon XL3 connectors are used. The projecting screw serves as switch by contacting battery.

Noise Figure

In this particular application, however, where there is noticeable separation between mike and source, it is very difficult to get an input signal higher than — 50 dbm.

Low noise performance of the original equipment can be maintained—or even improved upon—with the addition of the booster amplifier if it utilizes a low-noise transistor. The transistor noise figure should be about 12 db or lower.

Stability

Temperature stability is obtained by two means: base bias bleeder, and high emitter circuit resistance. To arrive at the values shown, the emitter resistor, R_4, was chosen to be as large as possible without reducing the collector-emitter voltage below about 2 v. For R_4 = 1500 ohms and an emitter current of .25 ma the emitter voltage will be about — 0.4 v. The base voltage will be only slightly higher than this, so with R_1 chosen to be 5100 ohms, which is more than ten times larger than the highest anticipated source impedance, R_2 must be 27K ohms when the bleeder is connected across a supply voltage of 2.6 v.

Using available formulas, it can be shown that the Stability Factor for this circuit is about 3.8, the leakage current appears in the collector circuit multiplied by a factor of 3.8.

Fig. 5 illustrates how the gain and collector current change for the indicated range of temperature. It should be pointed out that stabilization is not as critical, in one sense, in a transformer coupled stage as it is in an R-C coupled stage because the collector dc resistance in the former consists only of the transformer primary dc resistance, which is quite low—in this unit, 1200 ohms.

On the other hand, the primary dc directly determines the low frequency response, and for this reason it should be as stable as possible. If this circuit were not stabilized, the collector current would rise to about 1.2 ma at 140°F. The price of this amount of stabilization is additional battery drain due to the base bleeder, which in this case draws .08 ma.

(*Continued on page* 016)

CUES for Broadcasters

Magnecord Modification

ROBERT F. SCHLORFF,
Ch. Engr.
WDET, Detroit 2, Mich.

On the Magnecord P-60 and P-63 tape transport units, the capstan motor speed change switch is also the power on-off switch. In broadcast operation, where equipment is normally left on during the broadcast day, the capstan drive motor runs continually; this results in very high temperatures after a few hours, and could shorten the life of the unit.

This modification eliminates the necessity of turning off the entire unit when it is not in use. When the tape is threaded on the machine, the capstan motor is turned on as the tape break switch is brought up to operating position. It is necessary, when wiring the tape break switch into the circuit in this fashion, to re-connect the remote control wiring so that the capstan motor can operate whether or not the remote circuit is open (remote stop).

The following outline gives a step-by-step procedure for modifying the P-60 or P-63 tape transport units:

(1) Remove green jumper connecting center terminals of sections A and B of SW 101, located at lower left of unit when viewed from rear. Section A is on the right, and handles off-on function; Section B is on the left, and switches one set of windings from fast (blue) to slow (white-blue).

(2) Remove blue lead from TB 101-10, and the blue-white lead from TB 101-5; clip the wires as close to spade lugs as possible.

(3) Prepare a new jumper (or, if SW 101 has screw type terminals, use green jumper removed in step 1) to connect TB 101-5 to TB 101-10.

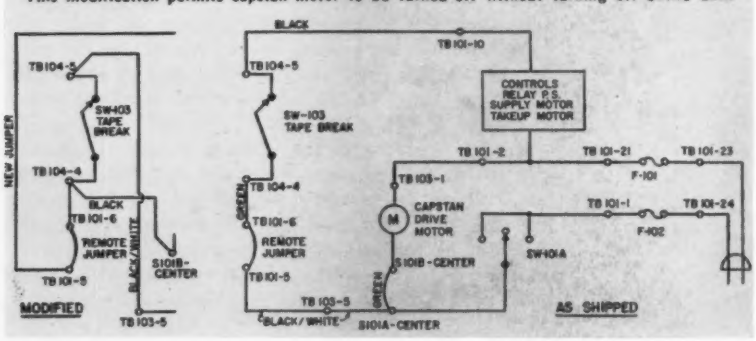
(4) Check connections at the left side (viewed from rear) of TB-104, which is located at top between brake solenoid and supply motor. Move either the green wire which runs to TB 101-6 or the blue wire which runs to TB 101-10, so both wires are connected to TB 104-4.

(5) Loosen cable clamp at lower left rear corner (viewed from the rear) of osc. control chassis, using needle nose pliers, carefully pull the blue wire and blue-white wire removed in step 2 above back through cable to point where cable branches off to TB 104 and to TB 103. Tighten cable clamp at the corner of osc. chassis.

(6) From cable junction mentioned above, run blue-white wire from TB 103-5 down to TB 104-5. This wire can be pushed into cable, and run inside lacing, or, if desired, can be run outside lacing and tied down in two or three places.

(7) From cable junction mentioned above, run blue wire from TB 104-4 over to center terminal of switch 101-B. This wire can be pushed into cable which runs to TB 103, and run inside lacing, and then into cable which runs to SW 101.

This modification permits capstan motor to be turned off without turning off entire unit.



"Plate On" Indicator

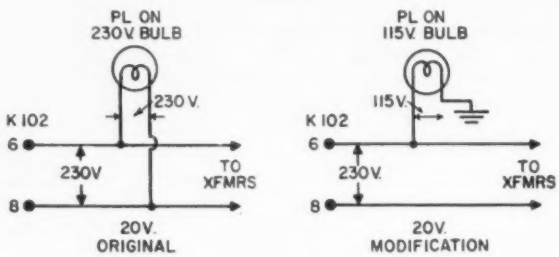
ED HOWELL, Tech. Supvr.
WMIX, Mt. Vernon, Ill.

Many stations are using the Collins 20-V. or other transmitter 230-v. lamps to indicate "plate on" condition. The life of these bulbs is not very long and replacements are expensive. Some operators prefer to install a S-6, 115-v. bulb and add a resistor to reduce the 230 volts to the 115 required for this type bulb.

A simpler method of converting to the relatively inexpensive, and always plentiful, S-6, 115-v. bulb is to lift one of the leads from the "plate on" pilot socket and tape it with high-voltage tape and then run a new wire from the vacated socket terminal to ground.

This places the S-6 bulb across one side of the 230-v. line and ground and will give indication when the plate is turned on same as if a 230-v. bulb were used and the current drawn from both sides of the line as in the original design.

By replacing one of the leads from the "plate on" pilot socket with a new wire to ground, the popular S-6, bulb, 115v., may be used as an indicator.



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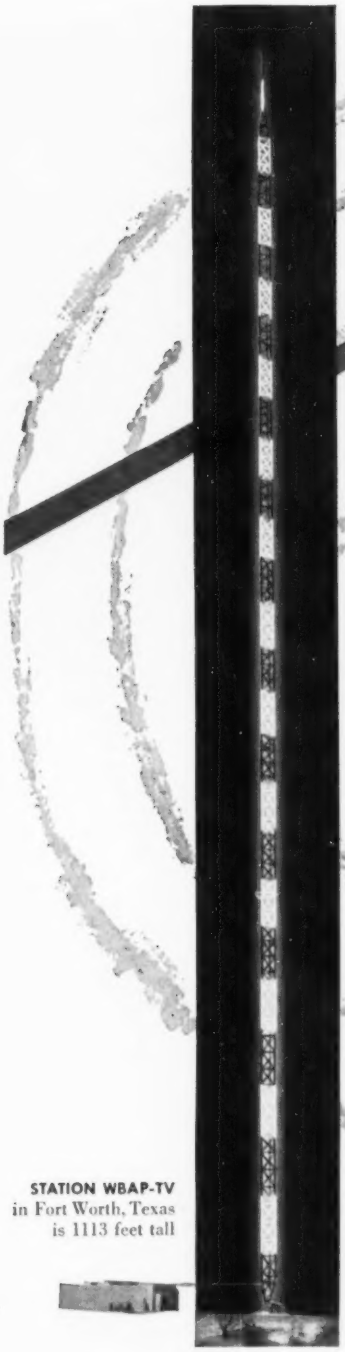
Would Increase Overtime On Missile Projects

Sen. Lyndon B. Johnson has proposed that the 40-hr. week be abandoned on missile projects in order to meet the schedule for the ICBM program.

The senator said that the principal bottleneck that he had found was the limitation on overtime. He reported that Neil H. McElroy, new Secretary of Defense, had already reported to the Senate Preparedness Committee that steps are being taken to authorize overtime in certain instances.

TV LAMP

A somewhat different version of the TV lamps so popular only a few years ago. This one uses a burned out image orthicon as the central pillar. A small lamp above the screen gives the tube a comforting glow for night light purposes. Three-way switch provides for brighter lights under the shade. Idea developed at GE's Tube Dept. in Schenectady.



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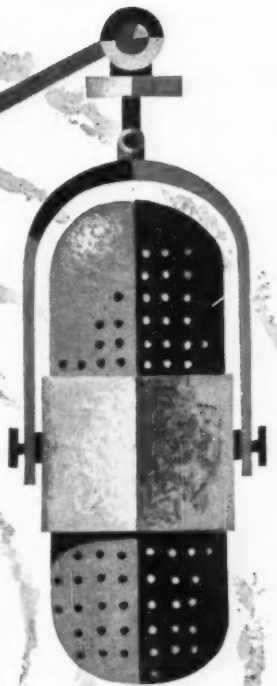

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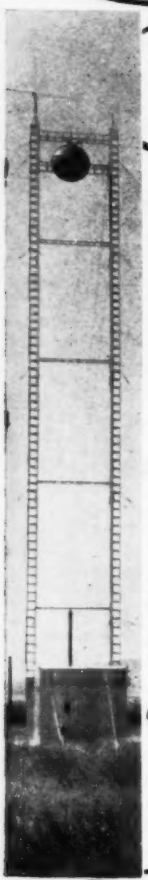

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VHF Transmitter

(*Continued from page* 03)

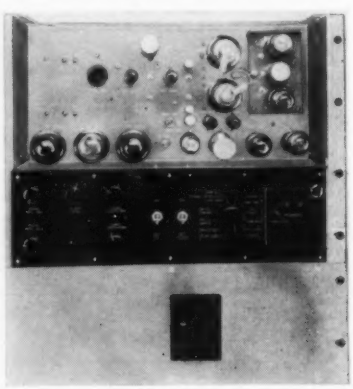
by precise adjustment of the r-f grid drive and broadbanding, be made essentially zero. With less precise adjustment it may amount to 2 or 3 ma. In either case, the modulator will not produce excessive differential phase shift. The overall modulator video response is essentially flat to at least 5.5 MC.

The metering circuit measures currents in the video amplifiers stages and r-f stages as well as the voltage output of the regulator and the black level voltage. The control panel contains controls for aural and visual r-f reflectometer calibration and r-f excitation as well as a black level control. The excitation controls are potentiometers which control the screen voltages of the 4-65A's. In the case of the low band aural amplifier, the screen voltage of the 4X250B is controlled.

Power Supply

A common high voltage supply is used for the aural and visual r-f stages (Fig. 5). Selenium rectifiers, rated for 25,000 hours minimum life without significant aging, are used. If the seleniums do age, a 5% voltage tap is provided on the transformer primary to overcome this aging for additional service. Four stacks are used in a full wave bridge circuit providing 1000 v dc. The center tap of the transformer supplying this bridge feeds the input of the electronic regulator at approximately 500 v dc. The plate transformer is visible just below the rectifiers in Fig. 4.

Fig. 4: Metering and control circuits are contained along with the video stages



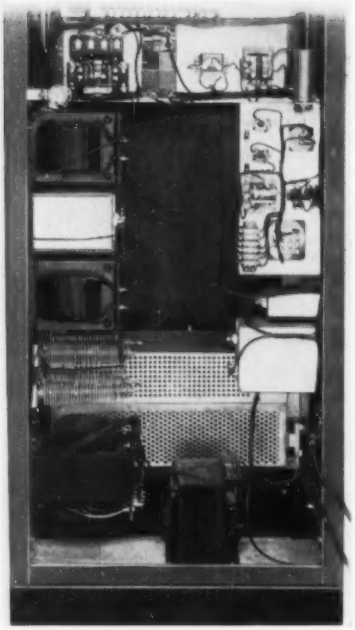


Fig. 5: Selenium rectifiers are rated for 25,000 hours' minimum life

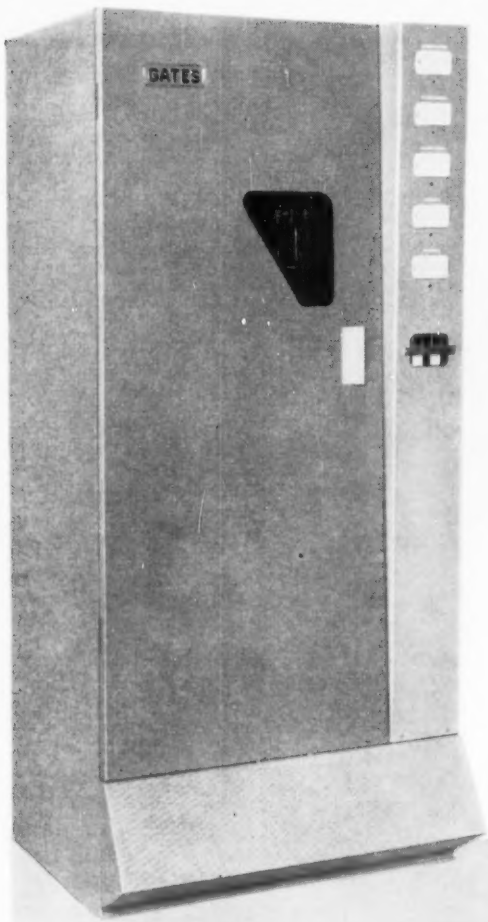
A small bias supply, using germanium rectifiers (upper right, Figure 5) is the only other power supply. Note that no tube type rectifiers are used, and because of the life expectancy of the rectifiers used, rectifier replacement should virtually be eliminated. The usual rectifier filament transformers and sockets are eliminated as a source of trouble and spare stocking.

Miscellaneous Features

Reflectometers are included in each output line from the aural and visual. These reflectometers incorporate directional couplers so a qualitative check can be made on the line VSWR by reversing the couplers. The type N fittings used in the output lines facilitate the reversal.

As noted earlier, the transmitter may be operated unattended. To this end, the ac power may be switched remotely over a light duty pair of wires. The transmitter incorporates a time delay relay and overload protection (See top of Fig. 4).

(*Continued on page* 015)



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THE INBUILT DUMMY ANTENNA was suggested by many broadcast men. "We want a way to do off-the-air testing that is positive, reliable, accurate and quick," they said. Now, for the first time, comes a transmitter, the Gates BC-1T, which offers this important exclusive.

THAT BOTHERSOME BACK DOOR consumes wasted floor space. "Let us have a transmitter 100% serviceable from the front," was a repeated suggestion. First again, comes a transmitter fully accessible from the front.

"FREQUENCY STABILITY must certainly be possible," broadcasters said, "without the crystal oven, thermostats and thermometers." BC-1T has dual vacuum type crystal units with pin-point stability and without ovens, thermostats and thermometers.

FIRST AGAIN is a broadcast transmitter with the uniformity and positive results of printed wiring. Here results are always the same. This tremendous plus tells the maintenance engineer his work is easier and management the initial cost is lower through technological progress.

An eight page color brochure describing each exclusive feature in detail is yours on request.

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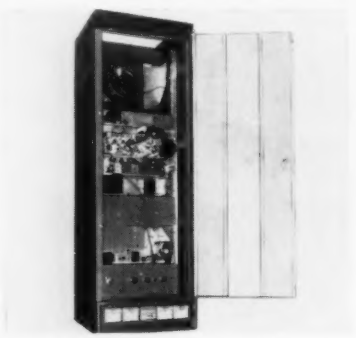
Circle 65 on Inquiry Card, page 97

New Products . . . for Communications

250 WATT STATION

A new high power UHF base station radio transmitter designed to give dispatchers of mobile communication systems more ability to reach vehicles traveling in outlying areas is

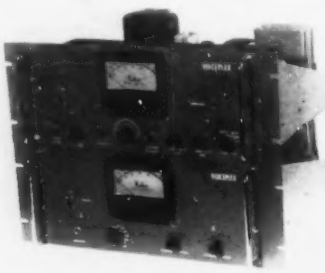


available. Engineered to deliver up to 250 watts, the unit may be licensed for operation in the 450-460 mc band. The new transmitter increases power output up to 12 db and enables dispatchers to talk up to 50% farther. Design is aimed at reducing maintenance and increasing reliability. General Electric, Communication Products Dept., Electronics Park, Syracuse, N. Y.

Circle 207 on Inquiry Card, page 97

MULTIPLEX SYSTEM

Voiceplex, utilizing a novel frequency division multiplex method, permits transmission of two voice channels in the same frequency spectrum normally occupied by one. Voice-



plex may be used on radio circuits, land-line telephones, VHF links, scatter relays, or any other type of facility requiring the transmission of voice messages. Spectrum requirements are only 300 to 3,000 cps. The complete system consists of a transmitter and receiver, each fitting into a 7 x 19 in. rack space Kahn Research Labs. Inc., 22 Pine St., Freeport, L. I., N. Y.

Circle 209 on Inquiry Card, page 97

WARNING SYSTEM

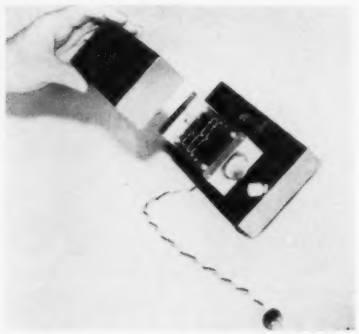
A newly-designed console model of Sigalert, an instantaneous emergency warning system is available. It is activated by signals in the below-30-cycle range. This is how it works:

An emergency is reported to the police department. The police radio dispatcher presses a button at his control panel which triggers Sigalert receivers. The signal automatically sets off an alarm and records the message on tape. Radio or TV station can immediately cut into the program on the air. Packard-Bell Electronics Corp., 12333 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 211 on Inquiry Card, page 97

POWER SUPPLY

A 25 w. "piggy back" transistorized power supply for existing two-way radio equipment, which guarantees over 80 percent efficiency has been developed. Although packaged specifically for existing Du Mont equipment, the new unit has electrical characteristics which make it useable with other manufacturers' equipment. Input voltage is 13.8 vdc nominal with



± 20% variation. Output voltage is 250 vdc ± 10 v. at a 90 ma. load. Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle 208 on Inquiry Card, page 97

POWER TETRODE

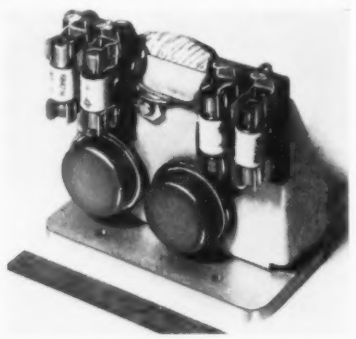
A new premium quality radial-beam power tetrode has been announced. This new addition to the Eimac line, designated the 4CX250B, is an all ceramic-metal version of the 4X250B. It has a plate dissipation rating of 250 w. and operates at maximum ratings through 500 mc. It has greater immunity to damage by mechanical shock and high temperature,

lower RF dielectric losses, greater dimensional stability and suitability to higher temperature processing. Eitel-McCullough, Inc., San Bruno, Calif.

Circle 210 on Inquiry Card, page 97

STATIC CONVERTERS

A complete range of transistorized static dc to dc converters for use where reliability and size are important is now available. Units are specifically designed for two-way radios, public address amplifiers, or wherever conventional power supplies are used. A typical receiver supply produces 250 vdc @ 130 ma or 290 vdc @ 130 ma from either 12 or 13.6 vdc input



and is in a 3⅜ x 1⅞ x 3¼ in. package. UAC Electronics Div. of Universal Transistor Products Corp., 36 Sylvester St., Westbury, N. Y.

Circle 212 on Inquiry Card, page 97

Phase Shifter

(*Continued from page 04*)

Flexible Lab. Phase Shifter

The writer has found the circuit shown in Fig. 2 to be generally useful in the laboratory. The front end of the circuit provides line frequency or the first few even harmonics thereof by switching directly to the secondary of a filament transformer or to the output of a 120- or 240-cycle filter which purifies the desired harmonic from a selenium rectifier. Terminals labeled "special input" permit the use of an oscillator or other source for signals of other frequencies. Terminals for observing or measuring the input signal before its phase is shifted are labeled "C.R.O."

The phase shifter proper uses a center-tapped plate-to-grid transformer to supply voltage to the sine-cosine potentiometer which, in this particular case, has a total resistance of 16,000 ohms. A switch permits selection of the appropriate capacitance to give 0.22 megohms of reactance for 60, 120, or 240 cycles. A pair of screw-type terminals on the back of the cabinet makes it convenient to insert a capacitor for any other frequency that may be required.

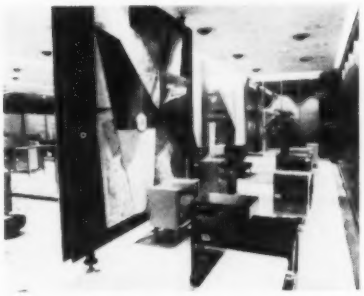
VHF Transmitter

(*Continued from page 012*)

If it becomes desirable to add the 500W linear amplifier at a later date to an existing TTL-100AL/-AH, provision has been made to accomplish this with no changes in the TTL-100AL/AH cabinet wiring. The interconnected ac control and protection circuits are brought out to 4 otherwise unused terminals in the TTL-100AL/AH. It is a simple matter to connect these 4 terminals to the 500W unit.

The TTL-100AL/AH has been designed and tested for color use. When used with the normal color input equipment, including the phase and amplitude control units and a color stabilizing amplifier, the unit will perform well within the color transmitter standards.

TV SHOWROOM



This new Zenith Display Salon in midtown N.Y.C. will be used by local area dealers and their customers as an extension of the dealers' own showrooms. Complete line will be displayed.

Air Force Reveals Infra-red Television

The Patent Office issued a patent to the Air Force last month on an infra-red television camera somewhat similar to the snooperscope and sniperscope of World War II.

The camera tube has a mosaic of lead sulphide, which is sensitive to infrared rays.

David A. Huffmann, of Cambridge, Mass. is the inventor of the system.

Private Firms Take Over Trade Fair Space

The U. S. government is withdrawing from the 1958 Paris and Stockholm International Trade Fairs and making all of the space available to U. S. manufacturers and their foreign distributors.

Exhibits are being restricted to manufacturers in the electronic and chemical industries in order to permit a coordinated display.

The funds previously earmarked for official U. S. exhibits at the fair will be diverted toward strengthening Government exhibits adjacent to and behind the Iron Curtain and in the "uncommitted" countries in Asia.

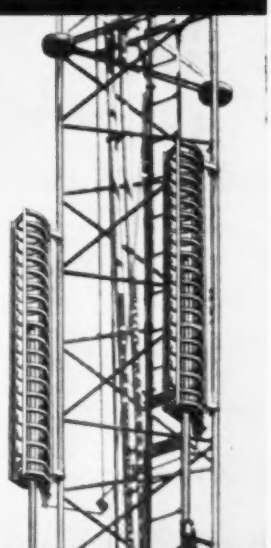
Moscow Tower Will Be Tops

The tower planned for the Moscow television center will be 1,640 ft. high—taller than the Empire State Bldg. tower and the Eifel Tower in Paris. Among the features will be skyhigh observation platforms halfway up and at the 1,300 ft. level.

STAND-BY ANTENNAS

for TV TRANSMITTING channels 7-13

No Diplexer Needed



A simple, versatile, and *economical* standby system consisting of two separate bays of the AMCI Type 1020 Antenna can be mounted on the legs of an existing tower. Shown here is the Station WXYZ-TV installation in Detroit, Michigan, being used with a 50 kw transmitter. They may also be mounted on FM antennas (Station WBKB-TV, Chicago, Illinois) and on masts, one above the other. The aural and visual transmission lines need not be of equal length.

Write for Bulletin B-957

AMCI

ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS

ALFORD *Manufacturing Co. Inc.*

299 ATLANTIC AVE., BOSTON, MASS.

Mike Booster (*Continued from page 07*)

Gain

The choice of 15 db for the gain of this amplifier was based mainly on the requirements of console operation. It was felt that any less gain would not handle the low level service in which the unit was to be used, and higher gain would result in overloading the console microphone preamplifier.

The precise amount is obtained by the correct value of R_3, and will be constant within $\pm$ 1 db, for nearly all transistors of the same type.

Power Supply

The last design factor of interest is the power supply. Since the uses to which this unit could be put might easily involve installation in out-of-the-way places such as above auditorium rafters or beneath a heap of studio mike cables, the power supply had to be self-contained and continuously energized. Mercury cells are ideal for this application, and two of them are used to provide a supply voltage of 2.6 v. These cells, which are Mallory type RM-12R, have a capacity rating of 3600 milliampere-hours.

For our total drain of .33 ma, then, the estimated life would be over 10,000 hours; and a conservative specification of one year may be applied. The amplifier will work, of course, with only one cell; the additional cell increases the maximum allowable output signal level by more than 5 db. This seems worth the extra cost and space.

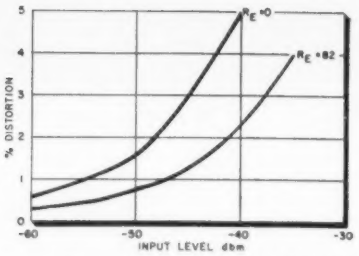
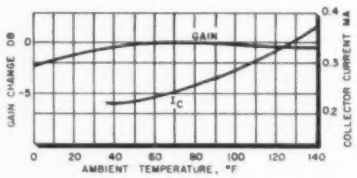


Fig. 4. Harmonic distortion is plotted against input level for R = O and 82 ohms.

Fig. 5: Gain and collector current vary with temperature. Stabilization is necessary.



ELECTRIC PLANT NEWS

Onan ELECTRIC PLANTS

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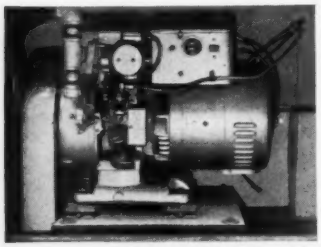
Complete studio on wheels has two transmitters, turntables, P.A. system, receiver, program console, lights, electric clock.



An Onan single-cylinder, air-cooled Electric Plant, Model 2LK1R, powers all the electrical equipment in this mobile unit of KPOJ, Portland, Oregon. It develops 2,000-watts, 60-cycle, 115 volts, with excellent stability of frequency and voltage.

Onan's exclusive Vacu-Flo cooling system permits mounting the plant in a closed compartment. Electrically started by push button, the plant runs smoothly, quietly; requires minimum servicing. **Models from 500 to 75,000 watts A.C.** *Also D.C. and Battery Charging Plants.*

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ANTENNAS, PROPAGATION

Series of Papers on Radio Astronomy. "Proc. IRE." January 1958. 50 papers, 347 pp. First publication to deal comprehensively with the engineering and equipment phases of this subject and it also presents new findings in astrophysics, for example, in connection with radio sources among the planets. Contributions have come from Australia, Japan, Canada, England, France, Belgium, Alaska, Hawaii, and the United States, and the list of authors includes a majority of the leading workers in this field. (U.S.A.)

Microwave Antenna Characteristics in the Presence of an Intervening Ridge, R. Vikramsingh, et al. "J. ITE." September 1957. 6 pp. Using two transmitters and two receivers operating in the 2,000 mc/sec. region, the following experiments were carried out, in the presence of an intervening ridge, between terminals which were 14 km. apart: (i) Using horizontal as well as vertical polarizations, beam shapes were determined in the azimuth plane and vertical plane; (ii) dependence of signal level on the angles of elevation of the axes of the parabolic mirrors was also studied; (iii) polarization patterns were recorded by rotating one dipole and keeping the other fixed; (iv) the effect of defocussing of the dipole with respect to the parabola on the received signal intensity was studied. (India.)

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* Those articles marked with an asterisk are available as free reprints to EI readers.

For more information on domestic articles, contact the respective publishers directly. Names and addresses of publishers may be obtained upon request from the address below.

All requests should be sent, on company letterhead, to: Electronic Sources Editor, Electronic Industries, Chestnut & 56th Sts., Philadelphia 39, Pa.

The Hamburg Medium Wave Aerial for Suppressing the Sky Wave Radiation Towards Langenberg, Edgar Mohr and Friedrich von Rautenfeld. "Rundfunk." December 1957. 12 pp. The common-wave operation of the two high-power medium wave transmitters on 971 kc/s, at Hamburg and Langenberg, gives rise to mutual interference during the hours of darkness. In order to protect the Langenberg service area, it is necessary to suppress the sky wave radiation from the Hamburg aerial at an angle of elevation of about 30° in the direction of Langenberg. The authors discuss the theoretical possibilities for solving this problem and show that the appropriate vertical radiation characteristic is best achieved by using a director aerial. The properties of a passive director, as determined from tests with scale models, were confirmed by measurements made in the air of the vertical radiation pattern of the Hamburg aerial, as well as by propagation tests. (Germany.)

Rhombic Aerials, F. J. Norman and J. F. Ward. "E. & R. Eng." November 1957. 6 pp. The design of a periodic rhombic aerial is examined and a method derived whereby a set of charts of open scale yields all the aerial parameters of practical significance for high-frequency operation. The angle of fire and the gain with respect to a dipole in free space are displayed for an adequate range of aerial side lengths and included angles. Corrections are given for the height above ground and a simple method to find the shape of the main lobe suggested. (England.)

Advantages of the Slot Antenna for Television Stations, N. Tomcio. "Can. Elec. Eng." November 1957. 3 pp. The increasing use of slot antennas in modern aircraft has been fairly well publicized in recent years but the advantages of the slot principle to television broadcast station operation may not be so well known. Although they are not intended to replace the turnstile antenna, some technical and cost advantage will be achieved by the station which can make use of a slotted cylinder antenna. (Canada.)

Some Investigations on Dielectric Aerials, R. Chatterjee and S. K. Chatterjee. "J. ITE." September 1957. 5 pp. A comparative study of the expressions for radiation pattern of a circular dielectric rod aerial excited in the HE_{11} mode as obtained by the Schelkinoff's equivalence principle and by the application of Huyghen's principle over the whole rod shows that in the $\varphi = 0°$ and $\varphi = 90°$ planes, the beamwidth of the major lobe and the structure of the radiation pattern differ in the former case but are the same in the

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electric Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bul. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El. Uber. Archiv der Elektrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Elektrotechniczne

USA

Auto. Con. Automatic Control
Av. Age. Aviation Age
Av. Week. Aviation Week
Bell J. Bell Laboratories Journal
Comp. Computers and Automation
Con. Eng. Control Engineering
El. Electronics
El. Des. Electronic Design
El. Eq. Electronic Equipment
El. Ind. ELECTRONIC INDUSTRIES
El. Mfg. Electronic Manufacturing
IRE Trans. Transactions of IRE Prof. Groups
I. & A. Instruments & Automation
Insul. Insulation
M/R. Missiles and Rockets
NBS J. Journal of Research of the NBS
NRL. Report of NRL Progress
Proc. IRE. Proceedings of the Institute of Radio Engineers
Rev. Sci. Review of Scientific Instruments

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences, USSR

OTHER

Radio Rev. La Radio Revue (Belgium)
Kovo. Kovo Export (Czech)
J. ITE. Journal of the Institution of Telecommunication Engineers (India)
J. IECE. Journal of the Institute of Electrical Communication Engineers (Japan)
Phil. Tech. Philips Technical Review (Netherlands)
Eric. Rev. Ericsson Review (Sweden)
J. UIT. Journal of the International Telecommunication Union (Switzerland)

latter case. It is also shown that Halliday and Kiely's theory, also based on Huyghen's ray theory, does not indicate any variation in these factors in the two planes. This is justified due to the vector nature of the Schelkinoff's principle and the scaller nature of the original Huyghen's principle. (Indin.)

Loop Aerials for Long Waves, Jurgen Wustenhagen. "Rundfunk." December 1957. 7 pp. The author examines the suitability of loop aerials for use in the long-wave band. The observations include the input impedance, the efficiency and the bandwidth. A theory cited at this point makes it possible to calculate the input impedance of loop aerials over a wide range of frequencies. It is confirmed by measurements that it is easy to vary the input impedance of loop aerials by varying the thickness and spacing of the elements. Consequently, loop aerials are more advantageous than linear aerials. (Germany.)

Feeder Protection, Part I, C. H. Lackey. "El. Energy." November 1957. 8 pp. This article reviews present-day British practice in the protection of lines and cables. Following a brief reference to time grading, the article describes various forms of pilot-wire protection for cables, carrier and distance protection for overhead lines, and the problems of feeder/transformers and teed feeders. It concludes with a general discussion and recommendations on fault settings and operating times. (England.)

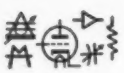
AUDIO

Latest Recording Techniques Improve Quality and Frequency Range, K. W. Lines. "Can. Elec. Eng." December 1957. 4 pp. Improvements are constantly being made in the techniques of sound recording and of producing phonograph records. The frequency response of records today covers the range of human hearing and the job of producing high quality records is becoming more complex. This article describes electronic and mechanical recording techniques. (Canada.)

The Dynamic Expander, W. Mortgat-Pick. "Radio Rev.," Vol. 9, No. 9, September 1957. 7 pp. Described are the principles of dynamic compression and expansion as used for sound recording. The detailed design of an expander is outlined, including calculations and frequency response curves. (Belgium.)

Continuous Telemeasurements of Audio-Frequencies, Designed for Frequency Modulation System, A. Nepomiastchy. "Bul. Fr. El.," Vol. 7, No. 78, June 1957. 10 pp. The article describes a supervisory system for a frequency modulation transmitter. A quantitative analysis is made and oscilloscope pictures are provided showing the influence of distortion in the transmission canal. (France.)

Evaluation of Frequency Response of Magnetization on Magnetic Sound Tape, O. Schmidbauer. "El. Rund." December 1957. 3 pp. After a discursion on frequency response standards, the method adopted by the German broadcasting system using the tape flux circuit is described. Error sources owing to typical gap errors are shown. Their influence can be reduced only by a multitude of measurements using a filtering method. The measuring method using a singular lead is discussed. A method for optimal head adjustment and thereby producing a gap direction tape is described. Finally, the head and screening shape influence at large wavelengths is considered. (Germany.)



CIRCUITS

***Integrating Voltage Sources,** George F. Schrader. "El. Ind." February 1958. 2 pp. DC amplifiers with capacitive feedback as voltage source integrators introduce errors not present when a current source is used. Operating conditions and errors produced are discussed. (U.S.A.)

***Simple Circuit Stabilizes Ferrite FM Modulator,** A. B. Przedpelski. "El. Ind." February 1958. 2 pp. Single-frequency FM modulators can be stabilized quite simply by detecting the modulated signal and feeding it back to the reactor. Here is a circuit which achieves the same simplicity in stabilizing a ferrite FM modulator over a range of frequencies. (U.S.A.)

Direct-Coupled Amplifiers, D. J. R. Martin. "E. & R. Eng." December 1957. 4 pp. The article describes a method of artificially matching valves to obtain improved mutual compensation for the effects of normal heater-supply voltage changes. Adjustment is easier than selecting naturally-matched parts of valves, and considerably better balance is obtained. (England.)

Frequency Stabilization of High-Frequency Transistor Oscillators by the Use of Temperature-Sensitive Components, H. J. Albrecht. "El. Rund." December 1957. 1 pp. A new method of frequency stabilization of transistor oscillators is described. Complete temperature compensation is obtained by the use of temperature-sensitive capacitors or coils. Details are given for the compensation by capacitors. (Germany.)

Nomograms Simplify Design of Cathode Coupled Amplifiers, A. E. Maine. "Can. Elec. Eng." November 1957. 5 pp. Analysis of the cathode coupled amplifier shows there to be a systematic relationship between the nearness to equality of the output signals, the degree of common mode rejection and the overall gain. Equations have been derived which, together with the characteristics of the tubes being used, reduce design to a straight-forward procedure. This is made even more rapid by the use of nomograms which represent the important equation. (Canada.)

Current Integrator For Astronomical Photoelectric Motometry, R. H. Weitbrecht. "Rev. Sci." November 1957. 6 pp. An integrator circuit is described, together with programmer and timer, which was constructed for measuring signal-current from a photomultiplier tube as used in astronomical photometry. At the end of a timed run, the voltage data are impressed upon a strip-chart pen recorder. The current-range of such instrument encompasses a span from 1 μamp to 10 μμamp, full scale, with stability and linearity. Furthermore, the design is such that, using a suitable programming circuit, any number of identical integrator units can be employed to measure a like number of separate photo-tube currents simultaneously over a given timed run; and afterwards the separate voltages are recorded in sequence upon the one recorder. This feature makes the herein described system very useful for simultaneous multicolor photoelectric photometry. (U.S.A.)

Calculation of Magnetic Amplifiers For A Specified Supply Voltage, N. P. Vasil'eva, O. A. Sedykh. "Avto. i Tel.," No. 11, 1957. 9 pp. It is shown that for a specified supply voltage and a specified load the volume of the amplifier is proportional to the ratio between the supply voltage and the load voltage when the magnetic mode of operation remains constant. Formulas and data are provided which make it possible to choose between an optimally-computed amplifier with a separate matching transformer and an amplifier computed for a specified supply voltage. Conclusions are drawn for amplifiers with and without feedback. (U.S.S.R.)

Design of Capacitive Divider Coupling Circuits, Irving Dlugatch. "El. Des." December 15, 1957. 2 pp. (U.S.A.)

Design and Manufacture of Practical Filter Circuits, S. Boyle. "El." December 1957. 4 pp. Anticipated performance is seldom achieved in passive filter circuits whose design is based solely on theoretical considerations. Distributed capacitance due to component proximity and encapsulating materials, temperature effects and impedance mismatch radically skew the results. (U.S.A.)

Single-Stage Circuits For Multiplying and Dividing The Frequency Of A Quartz Crystal, G. M. Utkin. "Radiotek," No. 9, 1957. 8 pp. Double-tuned self-excited oscillators with multiple frequencies are analyzed from the point of view of using them for multiplying or dividing the frequency of a quartz crystal. It is shown that the equations of such oscillators make it possible to assume that the synchronism zone depends upon the parameters of the oscillator and upon the frequency multiple. Such circuits can be practically utilized up to frequency multiples of the order of 15. Experimental data is provided. (U.S.S.R.)

Compact Supplies Have Wide-Range Regulation, W. F. Schreiber. "El." December 1957. 2 pp. Use of solid-state rectifiers and high-current regulator tubes eliminates power transformer and reduces size and cost of power supplies. (U.S.A.)

Ring Counters with Electronic Gate Circuit. "El. Rund." December 1957. 2 pp. By the application of transistors and germanium diodes, ring counters with electronic gate circuits can be constructed which are remarkable for small physical dimensions and low consumption. In the design of such circuits coupling effects must be taken into consideration. For the stepdown of the output impedance a tried-out circuit is given. (Germany.)

Dual-Purpose Circuitry Cuts Transceiver Size, Paul G. Wulfsberg and Charles H. Kirkpatrick. "El." December 1957. 3 pp. Reflex circuit techniques enable design of 1,750-channel transceiver employing only 35 crystals and 28 tubes. (U.S.A.)

An Amplifier for A. C. Bridges, A. H. Allan et al. "El. Eng." December 1957. 3 pp. The requirements of an amplifier for a.c. bridges working to an accuracy of one part in ten thousand or better, from power frequencies to audio frequencies, are discussed. An amplifier to meet, in part, these requirements, is described, and figures are given for its performance. (England.)

Monovibrator Has Fast Recovery Time, A. I. Aronson and C. F. Chong. "El." December 1957. 2 pp. Use of complementary transistors decreases recovery time of monostable multivibrator. (U.S.A.)

Transistor Oscillators and Their Sensitivity for Load Impedances, W. Herzog. "Nach. Z." November 1957. 6 pp. The second 4-terminal network equation for transistors is used for the determination of the "internal" feed-back in an oscillator circuit and the equivalence of this feed-back to the normal—external—feedback is shown. Two types of transistor oscillators are given which are insensitive to load impedances and the conditions are pointed out under which two load impedances can be connected simultaneously and without interfering with each other or with the circuit. (Germany.)

Stacked Valve Circuits, J. B. Earnshaw. "E. & R. Eng." November 1957. 3 pp. Stacked valve circuits are defined as arrangements where the valves are connected in series

across a common d.c. supply. A circuit common to all stacked valve arrangements is analysed and the results for specific circuits appear as simplifications of the general equations. The analysis, which contains no initial simplifying assumptions, combines the results of some well-known feedback theorems and uses modified equivalent circuits. (England.)

Transmitter Circuits For Suppressed-Carrier A-M, J. P. Costas and R. W. French. "El." December 1957. 4 pp. (U.S.A.)

COMMUNICATIONS

***Designing a Transistor Mike Booster,** John K. Birch. "El. Ind. Ops. Sect." February 1958. 2 pp. A delicate balance between theory and practical considerations results in a useful transistorized booster for insertion into remote microphone lines. The single-stage transistorized unit contains its own power supply, conservatively rated at one year. (U.S.A.)

A U.H.F. Wide Band Amplifier, J. Kason. "El. Eng." December 1957. 3 pp. A wide band u.h.f. amplifier of a mid-band frequency of 500 Mc/s and having a bandwidth equal to approximately 40 Mc/s is analysed. The anode and grid impedances of a stage are evaluated and a method of coupling, using a balanced delay line in the anode, is shown. The gain and noise factor are also considered. (England.)

The Three-Carrier Frequency Telephone System Z3F for Open Wire Lines, F. Vollnhals and F. Seibt. "Freq.," Vol. 11, No. 9, September 1957. 8½ pp. The carrier frequency telephone system Z3F is designed for open wire lines in the frequency range from 3.2 to 31 Kc. Three telephone channels and four AC telegraph channels are grouped together for operating in either direction. In addition to the standard audio frequency two-wire system, twelve-carrier frequency telephone circuits can be operated with the Z12F system designed to operate between 36 and 103 Kc. This system has been recommended by the CCITT. It permits parallel stringing of lines on the same telephone poles with a negligible amount of unintelligible crosstalk. (Germany.)

The Mechanism By Which Phase Distortion Arises When One Side-Band Is Partially Suppressed, A. B. Polonskii. "Radiotek.," No. 9, 1957. 9 pp. It is demonstrated that the phase distortion which arises when one sideband is partially suppressed is basically due to the fact that the carrier phase shift which arises in a single-side-band receiver leads to a displacement of all the modulating frequencies (which are transmitted by one sideband) through the same phase angle over which the carrier is shifted. Transient response is computed for a single-side-band receiver which has phase distortion. (U.S.S.R.)

Multiplication of Frequency-Modulated Waves over an Extremely Wide Frequency Band, H. Schoenfelder. "Freq.," Vol. 11, No. 9, September 1957. 4½ pp. The author illustrates the problems associated with frequency multiplication when using a serrasoid modulator. A single cascade stage is used for a frequency multiplication from 100 Kc to 100 Mc. (Germany.)

Fast Read-Out Chronotron System, Robert Meunier and Gilbert Davidson. "Rev. Sci." December 1957. 6 pp. A new electronic read-out system has been devised which enables one to obtain a fast answer from a chronotron to be used with accelerator beams of particles. It allows for an analysis of time delay with variable and continuous time intervals. The timing is pulse-height independent with an accuracy increasing for large pulses. The recovery time is in the range of one microsecond. With delay-line clipped coincidence pulses from two photomultipliers being fed into a 12-channel chronotron with a 30-usec range, a time resolution with half-width at half maximum of 1.2 usec was readily obtained. Using only 4 channels, with a range of 10 usec, a half-width at half maximum of .6 musec was observed. A simplified version with only three channels has made a useful fast coincidence circuit. (U.S.A.)

Training Sound and Television Technicians for the Broadcasting Organizations of the Federal Republic of Germany, Kurt Hoffmann. "Rundfunk." December 1957. 5 pp. The Rundfunk-Betriebstechnik G. m. b. H. in Nurnberg trains sound and television technicians for the particular operational tasks of the broadcasting organizations. The usual training covers three terms of half a year and is intended to provide the students with a foundation which will later on enable them to undertake more advanced work. In addition, there are courses of only two half year terms which are to alleviate the acute lack of technicians. There are also advanced courses of training for the technicians employed by the broadcasting organizations. The object of these courses is to introduce them to the latest advances in sound and television broadcasting and to deepen and extend their knowledge in their own particular field of activities. (Germany.)

Designing FM Systems with an Analog Computer, Henry A. Musk. "El. Des." December 1, 1957. 4 pp. (U.S.A.)

Back-Scatter Sounding: As Aid to Radio Propagation Studies, A. F. Wilkins and E. D. R. Shearman. "J. BIRE." November 1957. 16 pp. An historical account is given of investigations of back-scatter, and the evidence indicating the ground as the source is discussed. By means of the radar equation the echo intensity is calculated, and the effects of layer curvature and thickness are indicated. The marked seasonal variations in the echo patterns observed at Slough are discussed. Back-scattering after two or more ionospheric reflections is also considered, while very long distance scattering, sometimes with no intermediate ground reflection, is reported. (England.)

Short-Wave Radiotelegraph Communications between Ship and Coast Stations, B. Roig y Coll. "J. UIT." November 1957. 2 pp. (Switzerland.)

The Present Scheme for Attenuation Values in the Telephone Network of the Federal German Post Office, F. Bath, et. al. "Nach. Z." November 1957. 6 pp. The progress in telephone engineering demands new investigations concerning the attenuation schemes. The limits for the highest and the lowest permissible line attenuation are determined on the basis of recommendations given by CCITT. The attenuation scheme of the Federal German Post Office is described. All requirements are met in the national and international traffic. The special conditions in 4-wire exchanges and the requirements for hybrid circuits are discussed. (Germany.)

COMPONENTS

Transitor Relays Have Low Idling Current, D. W. R. McKinley. "El." December 1957. 1 pp. Electronic relays of remote-control devices operate electromechanical relays requiring 2 or 3 watts: consume few microamperes when idling. Circuits for c-w audio and pulsed-video control signals are shown. (U.S.A.)

Series Capacitors, S. Savir-Silberman. "El. Energy." November 1957. 7 pp. The use of series capacitors has proved to be a useful method for reducing the effect of line inductance in supply circuits having comparatively long transmission lines and in which the inductance of the line appreciably influences the voltage drop. In his article mathematical and graphical methods are given for determining the voltage drop and the rating of the capacitors needed to compensate for it. Special attention is given to the use of series capacitors with loads consisting of induction motors. (England.)

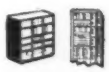
A New Type Of Wide-Band Transformer, Iu. M. Lebedev-Krasin. "Radiotek.," No. 9, 1957. 9 pp. A new type of wide-band transformer for the 10^3 —10^8 cps frequency band is described. The transformer can be used both in units designed for the simultaneous passage of signals with a wide frequency band, and for tuned amplifiers with a tuned frequency which can be smoothly adjusted over wide limits. In the latter case the transformer is specially constructed so that it can vary the tuned frequency inductively by means of electronic control. (U.S.S.R.)

Precision Variable Capacitors For High-Grade Electronic Equipment, A. A. Turnbull. "Brit. C. & E." December 1957. 4 pp. The development in recent years of electronic equipment, and especially Service equipment, of ever-increasing complexity to specifications calling for great accuracy has led to the demand for components of small size and possessing high performance. This article describes very briefly two types of precision variable capacitor developed for use in such equipment. They were designed to meet stability and accuracy specifications to an order that is normally associated with comparatively large-size precision capacitors, for laboratory use. (England.)

Properties of Zener Diodes and their Application as Voltage Standards, G. Meyer-Brotz. "El. Rund." December 1957. 2 pp. Zener diodes owing to their low breakdown voltage and the large blocking current range are especially suited as voltage standards in transistorized equipment or magnetic amplifiers. Like these they have a long life, small dimensions and high shock resistivity. The utilization of Zener diode properties for voltage stabilization purposes is shown with reference to examples. (Germany.)

The Transactor An Idealized Active Network Element, A. W. Keen. "E. & R. Eng." December 1957. 3 pp. The two-terminal constant-current and constant-voltage generators used in equivalent circuits of active networks are replaced by transmission-type active elements called transactors in order to display more accurately the transmission ('signal flow') properties of such networks. Four variants of the transactor are distinguished and their interrelationship is established. Justification for the introduction of these idealized active elements is found in the transactor-like properties of thermionic amplifier valves and other widely-used devices having similar properties, such as transistors. (England.)

Designing a Wide Range Spark Gap Switch, T. R. Nisbet. "El. Des." December 15, 1957. 4 pp. (U.S.A.)



COMPUTERS

***Checking on Computers, A New Approach to Verification,** Willia C. Eilander. "El. Ind." February 1958. 4 pp. With analog computers becoming larger and more complex, point-to-point checking of components is prohibitively time consuming. A computer whose unique problem analyzer reduces verification time to 40 minutes is described. (U.S.A.)

Puncher Transcribes Computer Output, J. E. Palmer, et. al. "El." December 1957. 4 pp. Transistor circuits consisting of two-input re-

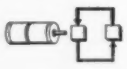
sistor gates, flip-flops and other delay circuits are combined in plug-in assemblies to provide logical and driving operations for card puncher that produces business machine cards at the rate of 150 a minute. (U.S.A.)

A Simple Shaft Digitizer and Store, A. Tiffany. "El. Eng." December 1957. 7 pp. The use of shaft position encoders to derive digital data from analogue instruments is discussed with particular reference to an extremely simple apparatus which has given very satisfactory service in daily use in a punched card data accumulating system. The encoder and the associated relay decoder-store are capable of being constructed in the laboratory or workshop. (England.)

Electronic Counters, Van Den Dungen. "Radio Rev.," Vol. 9, No. 9, September 1957, 8 pp. This is the first of a series of articles on electronic counters as used for radioactive material. Counters based on the binary system are described in detail, and circuit diagrams are given. (Belgium.)

Digital-Analog Converter Provides Storage, H. N. Putschi, et. al. "El." December 1957. 4 pp. When high-speed or environment rule out mechanical converters, purely electronic units must be employed. This transistorized converter changes eight binary bits, received in parallel from a shift-register, to 128 steps in amplitude of a 400-cps sine wave. (U.S.A.)

Ferroresonate Circuits for Digital Computers, C. B. Newport and D. A. Bell. "J. BIRE." November 1957. 12 pp. The characteristics of the ferroresonant circuit are analysed and conditions for bistability obtained. Problems of high frequency operation are considered and the composition and configuration of suitable ferrites discussed. A carrier frequency of 1 Mc/s seems to be the present limit. Practical circuits are presented for a shift register, 3-stage binary counter and 2-input logical adder. (England.)



CONTROLS

On Certain Features Of The Switching Operations Which Occur In Nonlinear Automatic Control Systems That Have A Nonlinear Element With A Sectionally-Smooth Characteristic, M. A. Aizerman, F. R. Gantmakher. "Avto. i Tel.," No. 11, 1957. 12 pp. Automatic control systems are examined in which the processes can be described by equations. The following cases are examined: (1) switching when the characteristics are composed of infinite curves; (2) switching when the characteristic is composed of segments of curves; (3) switching in systems with feedback that encompasses the nonlinear element. Certain of the switching processes which are analytically examined are reproduced by means of an electronic simulator. (U.S.S.R.)

A New Electro-Hydraulic High-Speed Servomechanism, C. H. Willard and C. A. Stemmer. "Auto Con." November 1957. 7 pp. This article describes the tuning of a modified magnetron using a hydraulic actuator to produce fast sweep functions. Specific circuitry for a number of components is shown. These are used in the automatic testing and evaluating of servomechanisms. (U.S.A.)

Control Circuit Design, N. B. Acred. "El. Eng." December 1957. 5 pp. The article describes a diagram method for the simplification of Boolean algebraic expressions. Further development of the method introduces the concept of time sequence, which facilitates the direct design of control circuits. (England.)

Optimalizing-Control Methods, I. S. Morosanov. "Avto. i Tel.," No. 11, 1957. 16 pp. The basic methods of optimalizing-control are analyzed. Systems are classified according to the method by means of which the optimum is sought. Optimalized relay systems are used as an example to demonstrate the special features of computing self-oscillatory modes. Brief recommendations are given for the practical utilization of such systems. (U.S.S.R.)

Six Control Problems Solved by Magnetic Amplifiers, A. E. Maine. "Con. Eng." December 1957. 7 pp. Engineers are still finding more uses for magnetic amplifiers. On the following pages, the author describes six interesting applications his company has found for these rugged control elements. Each description is presented as the solution to an actual control problem. As a basic control element, the magnetic amplifier complements rather than replaces the vacuum tube, particularly in more complex problems. (U.S.A.)

The Human Operator In A Control System, G. G. Sutton. "Brit. C. & E." December 1957. 6 pp. Various aspects of human engineering and its influence on the design and operation of electronic and associated equipment have already been described in a number of articles in this journal. This article examines more fully the performance of an operator in a closed-loop control system. (England.)

The Approximate Determination Of Probability Characteristics For The Output Coordinates of Nonlinear Automatic Control Systems, B. G. Dostupov. "Avto. i Tel.," No. 11, 1957. 11 pp. A method is given for approximately determining the moments of an integral system of ordinary differential equations according to the specified coupling moments of the random parameters which enter into the equations. The method is based upon utilizing finite segments of power-series expansions (with respect to the random parameters) of the integral of the specified system. (U.S.S.R.)

Computing-Control Applied to an Airborne Fire-Controller, Robert C. Pfister, E. Edward Buder. "Con. Eng." September 1957. 3 pp. Computing-control of airborne gunnery systems represents a mature application of computers to process control. The particular system discussed here tracks another aircraft, determines ballistic and kinematic effects, and computes the necessary prediction angle for a projectile. Specific details about any one airborne fire-control system remain under security wraps. However, the authors point out the input information needed by the computer, show how exact equations are found by using a ground-based digital computer, and discuss the equipment actually used as hardware to solve the necessary prediction angle equation. (U.S.A.)

Integral Canonical Representations Of Random Functions And Their Use In Determining Optimum Linear Systems, V. S. Pugachev. "Avto. i Tel.," No. 11, 1957. 14 pp. The method is used to determine the optimum linear operator, and a formula is derived for the weighting function of an optimum unidimensional linear system in the case of an infinite sampling interval (a system with an infinite memory) where the sampled random function is the result of the passage of "white noise" through a certain linear system. In particular cases the derived formula yields the well-known Wiener and Booton formulas. (U.S.S.R.)

On Diminishing Nonlinear Distortion By Means Of Feedback, L. Ia. Kantor. "Radiotek.," No. 9, 1957. 8 pp. The paper shows that high-frequency nonlinear distortion in feedback amplifiers should be evaluated solely according to the difference-tone coefficient. Formulas are derived for the computation of this coefficient. Methods are proposed for increasing the efficiency of feedback at the higher frequencies. The concept of a system with a "frequency-dependent nonlinearity" is refined, and various distortion indices are compared for such systems. (U.S.S.R.)

Some Aspects of Process Control Instrumentation, J. R. Halsall. "J. BIRE." October 1957. 11 pp. This paper discusses some of the instrumentation aspects of process control. It considers the electrical methods of measuring temperature and includes a description of the low-level d.c. amplifiers used in connection with thermo-couple measurements based on the contact modulator, galvanometer-photocell and galvanometer-oscillator methods. The application of van controlled r.f. oscillators to direct-current telemetering systems and electrical force balance measurements are also described and discussed. (England.)

Computing Control Applied to Wind Tunnels. "Con. Eng." September 1957. 4 pp. The author picks three problems in continuous and blowdown wind tunnels that lend themselves to that area of computing-control handled by a controller and an assortment of common transducers and circuits: surge control to protect air compressors, correcting for variations in gain, and computing the density corrections for the compressed air. (U.S.A.)

INDUSTRIAL ELECTRONICS

A Pneumatic Optimalizing Controller, Iu. I. Ostrovskii. "Avto. i Tel.," No. 11, 1957. 7 pp. The paper describes a pneumatic optimalizing controller which was developed in the Institute Of Automation And Remote Control of the Acad. Sci. U.S.S.R. Laboratory test data is provided. (U.S.S.R.)

Automatic Ultrasonic Inspection, H. W. Taylor. "J. BIRE." November 1957. 13 pp. Manual ultrasonic flaw detection has been employed as an industrial inspection method for several years. Using this technique very high standards of inspection were maintained. It is, however, not suitable for modern speed production conditions. The factors limiting the application of manual inspection under these conditions are considered and a description given of the fully automatic equipment recently developed to overcome these limitations. (England.)

Computing-Control Applied to a Tapered-Sheet Leveler. "Con. Eng." September 1957. 3 pp. The author uses a group of operational-amplifier integrators, in conjunction with amplidynes, relays, and motors, to automatically compute linear taper signals and position the leveler's work rolls. Reference signals fed into the computing integrators tilt the rolls before starting the leveling operation, thus assuring that all rolls are in the correct relative position for leveling or straightening the previously tapered aluminum sheet. (U.S.A.)

Stabilization for Progressive Commands, K. Raylee. "Radio Rev.," Vol. 9, No. 9, September 1957. 4 pp. The article describes servo-mechanisms which can be employed over a wide range. Circuit diagrams for industrial applications are given. (Belgium.)

Automatic Inspection As The Key Control Element In Full Automation, J. A. Sargrove and D. L. Johnston. "J. BIRE." October 1957. 7 pp. A fully automatic process is essentially an exercise in "system design," and in the simple application of the techniques of analogue or digital computers. The feedback signals to control and stabilize the system will be originated by inspection or measuring devices, dependent on the human senses or automatic instrumentation. The characteristics of a number of classes of such systems are distinguished, as well as the special requirement of the inspection equipment, which must have a higher order of reliability than is usually associated with laboratory measuring instruments. (England.)

The Switching System for the Telephone Network of the French Electric Power Company, G. Grand and G. Galy. "Bul. Fr. El.," Vol. 7, No. 80, August 1957. 12½ pp. The author outlines the telephone network of the French Electric Power Company, including historic review. Systems specifications are discussed in detail. The articl also outlines future plans. (France.)

A "Basic" System of Position Control for the Traversing Tables of Machine Tools, K. J. Coppin. "J. BIRE." October 1957. 13 pp. The processes carried out by machine tools are divided into two types—"progressive" e.g. profile milling, grinding, turning, in which cutting and traversing operations occur simultaneously, and "non-progressive"—e.g. drilling, boring, punching—in which they alternate. The requirements for automatic control of each type of process are considered in detail, and a specification worked out for a "basic" system of position control for application to "non-progressive" processes, to which may later be added facilities for carrying out some "progressive" processes. (England.)

How To Establish the Control Problem for an On-Line Computer, E. W. James and A. S. Boksenbom. "Con. Eng." September 1957. 12 pp. (U.S.A.)

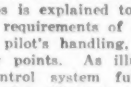
The Analog Computer as a Process Controller, D. W. Russell, et. al. "Con. Eng." September 1957. 5 pp. (U.S.A.)

Converting Process Data into Controller Inputs, R. O. Maze. "Con. Eng." September 1957. 7 pp. (U.S.A.)

From Controller Output to Process Actuation, J. M. Salzer. "Con. Eng." September 1957. 7 pp. (U.S.A.)

Role of Statistical Computation in Machine-Tool Feedback Gaging, D. N. Smith. "Con. Eng." September 1957. 7 pp. Increasing demand for 100 per cent inspection in parts manufacturing has brought the statistical quality-control computer close to the feedback gaging loop. Described here is a mechanization of the statistical concept of "precontrol," wherein the Gaussian curve computed for a given application is designed directly into the circuit. Innovations include selective, rather than continuous, response and the use of statistical mathematics as criterion for process adjustment. (U.S.A.)

The Application of Analogue Computer Techniques To The Design of Aero Engine Control Systems, A. D. Jeffrey, et. al. "J. BIRE." November 1957. 15 pp. The problem of aero engine control systems is shown to have reached the degree of complexity at the present time that makes it necessary to embark on analogue methods of simulation in order to predict the behaviour of the system. The parameters to be controlled are discussed and the way in which interaction may affect the individual loops is explained together with a review of the requirements of a control system from the pilot's handling, and the performance view points. As illustrations, examples of control system functional components are used to illustrate the methods of adaptation of a practical hydraulic system to analogue methods. The use of the computer results in discussed formulating an optimum system design. (England.)



MATERIALS

The Propagation Characteristics of Electro-Magnetic Waves Inside Axially Stacked Metal Rings, G. Piefke. "Arc. El. Uber.," Vol. 11, No. 10, October 1957. 5½ pp. The paper investigates the propagation of electro-magnetic waves in a wave guide consisting of axially stacked metal rings which are insulated from each other. The axial thickness of the rings including the insulation is far below the guided wave length. Formulae are given for calculating the propagation constants for all modes which can be propagated. Of interest is that the phase velocity of some of the modes exceed the velocity of light. Modes whose phase velocity exceeds the velocity of light correspond either to the H_{mn}— and E_{mn}— modes or the E modes with very high attenuation. (Germany.)

Dielectric Walls With A Small Reflection Coefficient at Microwave, H. Meinke. "Nach. Z." November 1957. 8 pp. A summary is given relating to the various methods for manufacturing walls with a small reflection coefficient over a narrow band as well as a wide band. The properties of suitable synthetic dielectrica, particularly in a mixture with graphite dust and ferrous dust, are compiled. (Germany.)

Germanium, an Industrial Metal, P. B. DeCleeny. "Onde," Vol. 37, No. 365-366, August-September 1957. 23 pp. The semi-conducting properties of germanium have become of increased importance in the past few years. The article describes where germanium is found and the methods of extraction and purification. Described in detail are the processes used by the Société Générale Métallurgique de Hoboken (Belgium)—extraction by reduction volatilisation. Also estimated are the abundant resources at Katanga and in Southwest Africa. The second part of the article deals with principle applications of germanium, such as diodes, transistors, rectifiers. (France.)

Aluminum Welding Easy With Low Temperature Fluxless Solder, S. Freedman. "Can. Elec. Eng." December 1957. 4 pp. Welding or soldering of aluminum—an alloy which is finding increasing application in electronics work—has been a difficult procedure requiring specialized knowledge and the use of corrosive fluxes. A low temperature fluxless solder has been developed which allows welding and soldering of aluminum. Temperature required is only 500° F. (Canada.)

Soft Solders in Electrical Engineering, A. Keil and H. Armbruster. "El. Rund." December 1957. 3 pp. The group of soft solders comprises alloys with lead, tin, cadmium and zinc basis having fusion points between 144 and 304 centigrades. For special purposes small quantities of silver (or copper) are added to these solders. Bismuth alloys have fusion points between 70 and 124 centigrades. They are used occasionally as solders, chiefly they are employed as fuses. Indium solders are destined for special purposes if the wetting of glass panes or the realization of particularly low melting points is required. The selection of proper fluxes is decisive for the solder process, strongly active chemicals are indispensable in the soldering of base metals; their residues must be carefully removed. (Germany.)

Reflexion and Shielding Characteristics of a Metallic Enclosure upon Electro-Magnetic Waves, H. Kaden. "Arc. El. Uber.," Vol. 11, No. 10, October 1957. 13 pp. The reflexion and shielding characteristics upon an electromagnetic wave striking a metallic shield is investigated for three cases: (1) Hollow cylinder whose axis is parallel to the electric field of the incoming wave. (2) Hollow cylinder whose axis is parallel to the magnetic field of the incoming wave. (3) Hollow sphere. (Germany.)

MEASURING & TESTING

***A Prospectus on Medical Electronics, Part 2,** R. G. Stranix. "El. Ind." February 1958. 5 pp. This article presents a quick survey of recent developments, a calculated guess of what's anticipated, and information on how the interested engineer or manufacturer can break into this field. Also, a few tips on selling to the medical profession. (U.S.A.)

***Measuring Frequency of X-Band Standard Cavities,** William A. Gerard. "El. Ind." February 1958. 5 pp. Excellence in stability, temperature compensation, shock, and vibration is determined by measuring the frequency under environmental conditions. Though measurement by frequency change is possible, such systems have proven inflexible. Recent advances in technique and further improvements are noted and discussed. (U.S.A.)

The Evaluation Of The Distribution-Law Parameters Of A Random Function When The A Priori Data Is Limited, Iu. P. Leonov, L. A. Telksnis. "Avto. i Tel.," No. 11, 1957. 14 pp. The method makes it possible to determine the probability-distribution parameters of a random function when limited a priori data is available with respect to the random function. It is demonstrated that the a priori data on the parameters which we are attempting to evaluate can be reduced if it is possible to verify the correctness of the hypotheses which have been made with respect to these parameters. One particular method of performing such a verification is analyzed. (U.S.S.R.)

Proving Reliability?, Larry D. Smith. "El. Des." December 1, 1957. 3 pp. This is an approach to proving that a given equipment has the necessary reliability to do the job. One practical concern of the design engineer is the production of a piece of electronic gear that is not over-reliablized. Extra quality costs extra money, though it shortens the testing time required to meet buyer's specs. The problem of the designer is to find the point where the derivative is zero, between testing time and added reliability. (U.S.A.)

Spot Scanner Counts Micron-Sized Particles, H. P. Mansberg, et al. "El." December 1957. 5 pp. Moving target indicator spots and counts bacteria colonies randomly distributed over a flat surface. U.S.A.)

Measuring Earth Conductivity, M. Strohfeldt. "E. & R. Eng." November 1957. 3 pp. (England.)

Vibration Measurements Employing Ba Ti O_3 Accelerometers, Jens. T. Broch. "El. Eng." December 1957. 5 pp. The possibility of measuring the properties of mechanical structures by means of electrical methods is generally appreciated. However, the introduction of piezo-electric ceramics such as barium titanate opens new possibilities in miniaturizing the mechanical-electrical transducers, thereby reducing the 'back effect' of the transducer upon the test-object, and making measurements possible in places where space is limited. (England.)

Shock Testing Procedures and Equipment, C. A. Mills. "Environmental Quarterly." 4th Quarter 1957. 4 pp. Shock testing is now used for everything from jet and rocket take-offs . . . to naval near misses . . . to handling, transportation and rough landings of Signal Corps materials. From our very good neighbor, Canada, comes this brief history of shock testing plus a description of current devices and techniques. (U.S.A.)

Realistic Tube Testing, J. M. Lowery. "El. Des." December 15, 1957. 4 pp. (U.S.A.)

Training Potentialities of Synthetic Missiles, J. Gordon Vaeth and Lt. Comdr. John Husson. "M/R." December 1957. 2 pp. (U.S.A.)

Ballistic Range Telemetry System Speeds Data Recording, D. L. Duff. "Can. Elec. Eng." December 1957. 4 pp. Time-consuming methods used in recording data on ballistic missile ranges can be replaced by a telemetry system. This requires the design of a transmitter to fit into a missile three inches in diameter and

16 inches long. The transmitter allows information on a flight to be recorded instantaneously. (Canada.)

The Evaluation Of The Noise Stability Of Radio-Reception Methods Which Are Based Upon Averaging Functions Of The Signal And The Noise, N. L. Teplov. "Radiotek.," No. 9, 1957. 9 pp. The paper performs a generalized analysis and comparative evaluation of radio-reception methods which are based upon averaging functions of a signal and random noise. (The method of multiple repetition, the integral method of reception, the storage method and the method of discrete averaging.) The resulting conclusions and expressions can be used directly for computing the noise stability of specific radio receivers which operate according to the indicated principles of reception. (U.S.S.R.)

Sampling Oscilloscope for Statistically Varying Pulses, Robert Sugarman. "Rev. Sci." November 1957. 6 pp. A sampling oscilloscope is described. Maximum useful sensitivity about 15 mv/in. These are limited solely by the peak time jitter, and apparent input peak noise of about 300 μV. Unlike prior sampling devices, pulses of constant or random repetition rate are displayed with equal facility. The usual time jitter associated with the display of random pulse heights is eliminated by selecting for display only those pulses that fall within a kicksorter channel. The average wave form of pulses with moderately irregular shapes is particularly easy to measure. (U.S.A.)

TERRIER Electronic Reliability, Russell R. Yost, Jr. and Fred Dreste. "M/R." December 1957. 3 pp. (U.S.A.)

The Creation and Test of Ultra-High Vacuums, F. A. Baker and J. Yarwood. "Vak. Tech.," Vol. 6, No. 7, October 1957. 7 pp. Ordinary vacuum pumps and diffusion pumps are unsuitable for creating ultra-high vacuums. Getter and specially constructed ionization manometers which simultaneously act as an ionization pump are employed. The amount of vacuum can be determined either with the ionization manometer or with the "flash filament" method. Also described is the Alpert air valve which can be operated at elevated temperatures up to 590° C. (Germany.)

Formulae for Characteristic Frequencies of the Dipole Equivalent to a Piezo-Electric Resonator, P. Andrieux. "Onde.," Vol. 37, No. 365-366, August-September 1957. 4 pp. The article gives the relations between the various characteristic frequencies of a crystal resonator. Terminology is included concerning the characteristic frequencies of a resonator which agree with the IRE recommendations and with the new addition of the unified CCTV specifications for porous crystals. (France.)

Focusing Procedures for Electrostatic Accelerators, C. H. Johnson, et. al. "Rev. Sci." November 1957. 7 pp. Ion optics for Van de Graaff accelerators are reviewed in elementary terms of geometric optics with particular reference to the Oak Ridge 3-Mv accelerator. This machine produces well-focused beams of over 100 μa and pulsed peak currents of several hundred μa. The beam diameter measured at a distance of 2.7 tube lengths from the accelerator tube exit decreases from 0.26 in. at 0.38 Mv to 0.10 in. at 2.47 Mv. The beam divergence at 1.8 tube lengths from the exit is nearly constant. (U.S.A.)

Noise Voltage Measurements on Low Impedance Circuit Elements With The Aid Of A Valve Voltmeter With A Preceding Transformer, W. Nonnenmacher. "Nach. Z." November 1957. 5 pp. It can be shown that equivalent noise impedances of less than 1 Ohm can be obtained in the low and medium frequency ranges on a valve voltmeter when an input transformer is employed. In this way it is possible to measure the thermal noise in circuit elements with a very small impedance. Additional noise from the transformer can be avoided. (Germany.)

Computation of Crystal Admittance, W. J. Lucas and P. B. Barber. "E. & R. Eng." December 1957. 5 pp. The paper summarized the results of a digital-computer programme designed to calculate the admittance, relative to 1/68 mho, of a coaxial crystal with the same dimensions as the CV2226 for various values of the video resistance R, spreading resistance r and barrier capacitance C over a frequency range 2,000-18,000 Mc/s. The equivalent circuit used in the calculation is discussed. From all the available measurements made on CV2226 crystals the variation with frequency of the admittance of an 'average crystal' was obtained. (England.)

Automatic Evaluation of Printed Circuit Receptacles, E. C. Bean. "NRL." October 1957. 4 pp. A machine that automatically collects life test data on printed circuit receptacles has been designed and developed. Up to 4000 cycles of test data can be recorded during one test run. (U.S.A.)

RADAR, NAVIGATION

Polarization DF-System, J. Grobkopi and K. Vogt. "Nach. Z." November 1957. 8 pp. Theoretical and experimental investigations concerning a new direction finding system for short waves free from night error are presented. The advantage of the new system, when compared with the conventional Adcock system of comparable qualities, is given by its smaller dimensions. (Germany.)

NRL Contributions to an Automatic Approach and Landing System, H. W. Chitty, et. al. "NRL." November 1957. 9 pp. The Navy's experimental automatic landing system is intended to relieve pilots of the hazards of landing aboard aircraft carriers, especially during bad weather. In recent successful demonstrations, thirty-one automatic approaches to touchdown, including six arrests, were made aboard the USS ANTIETAM, off the coast of Pensacola, Florida. The original and precontractual phases of this development, which were accomplished by the Naval Research Laboratory, are reviewed in this article. (U.S.A.)

Coupled Cavity Stabilization of Klystrons, Maurice St. Clair. "Electromechanical Design." November-December 1957. 4 pp. (U.S.A.)

TACAN Gives Pilot Continuous Indication Of Aircraft Position, W. Arthur Steel. "Can. Elec. Eng." December 1957. 6 pp. The TACAN radio navigation system provides military or civil pilots with continuous, precise distance and bearing information for navigation. It has an effective range of up to 200 miles and comprises both ground beacons and airborne equipment. The system has been under development for the last ten years but military security restrictions have limited the release of detailed information until recently. (Canada.)

Requirements for the Symmetry of Cables Used in a Two-Channel Direction Finder, G. Ziehm. "Freq.," Vol. 11, No. 9, September 1957. 7 pp. Usually, symmetrically-arranged shielded cables are used between the receiver and the direction finding antenna system. When the length of the cable approaches ¼ of the wave length, a small difference in length between the two antenna cables can cause errors in the indicated direction. The errors depend upon the difference of the cable lengths, and the loading of the cables. The relation between the various factors is analyzed. (Germany.)

Course Coupling Equipment, K. Zeilinger. "El. Rund." December 1957. 4 pp. Referring to the example of course coupling developed by the French aircraft manufacturers SNCAN, Chatillon, the problems involved in the design of single purpose analogue computers and their mastering by the methods of electromechanical control techniques are shown. These are advantageous with regard to the small space demand and weight of the entire outfit which are important features for airborne installation. The electromechanical version, therefore, is preferred to the purely electronic conception. (Germany.)

Twin Cavity for NH^2 Masers, J. Bonanomi, et. al. "Rev. Sci." November 1957. 3 pp. A system of two coupled cavities is described replacing the single cavity of an NH_3 maser. Using this system the curve of the oscillation frequency against cavity temperature presents a plateau, thus reducing considerably the "pulling" effects of the cavity. (U.S.A.)

SEMICONDUCTORS

***A Transistor Tester for the Experimental Lab,** Roy A. Hemper. "El. Ind." February 1958. 4 pp. The electronics laboratory often finds use for simple "kit" or "home-brewed" test equipment. Here is a carefully designed transistor tester which will prove invaluable for checking transistor parameters. The author has designed a self-contained instrument which is simple and economical to build. (U.S.A.)

Transistor Noise Operating at Audio Frequencies, H. Schubert. "Arc. El. Uber.," Vol. 11, No. 10, October 1957. 8 pp. This article is the third part of a series of articles. It provides a thorough analysis of the noise generated in transistors at audio frequencies. (Germany.)

Effects of Nuclear Radiation on Transistors, A. J. Schwartz. "El. Des." December 15, 1957. 4 pp. (U.S.A.)

After 80 Years the Hall Effect is Being Put to Work, T. R. Lawson. "Can. Elec. Eng." November 1957. 3 pp. The Hall effect, though interesting scientifically, apparently had no practical significance when it was first noted by Professor Hall in 1879. Until fairly recently it remained a scientific phenomenon. Now, with increased knowledge of semiconductor materials it has practical applications. Devices being developed show promise as analog computer elements and could revolutionize methods now being used for measuring some electrical quantities. (Canada.)

The Elemental Semiconductors—Silicon and Germanium, Part 2, J. Shields. "El. Energy." November 1957. 6 pp. (England.)

The Application of Semi-Conductors for Certain Problems in Meteorology, M. P. Aigrain. "Bul. Fr. El.," Vol. VII, No. 82, October 1957. 4 pp. The article briefly outlines the theory of semi-conductors and transistors, and discusses the application of photo-transistors in the field of measuring technique. Emphasized is their application with mirror galvanometers. (France.)

How Transistors Operate Under Atomic Radiation, Robert L. Riddle. "El." December 1957. 3 pp. (U.S.A.)

Time Lag of Impulse Operated Solid-State Diodes, W. Heinlein. "Arc. El. Uber.," Vol. 11, No. 10, October 1957. 10 pp. The common cause for a capacitive blocking lag or an inductive forward lag is the stored charge in the semi-conductive region outside the barrier of the p-n junction. The quantity of the

stored charge is calculated and a test method devised. The time lag of the forward conductance is caused by increased conductance in the diffusion regions. (Germany.)

TELEVISION

***VHF TV Transmitter for Low Power Operation,** Robert S. Jose. "El. Ind. Ops. Sect." February 1958. 2 pp. The small TV transmitter described is designed to fill the need for inexpensive, low power VHF transmitting equipment. It will serve in such applications as VHF satellites, small market service in conjunction with a rebroadcast receiver and as a driver for a 500 watt linear amplifier. (U.S.A.)

Waveform Testing Methods for Television Links, A. R. A. Rendall. "E. & R. Eng." December 1957. 3 pp. The subjective effects of phase and frequency distortion in television links are not readily discernible from steady-state measurements of transmission characteristics. Since the fundamental requirement is the preservation of waveform, a system of testing the waveform distortions to subjective picture quality, and a factor established. (England.)

Testing of Television Measuring Demodulators and of Television Direct-Rebroadcast Receivers, Heinrich Thielcke. "Rundfunk." December 1957. 11 pp. After discussing the television signal on the radio-frequency propagation path, the paper investigates the case of reception with a Nyquist receiver. It deals in particular with the factors which must be taken into consideration when testing such a receiver, notably non-linear distortion when demodulating a single sideband signal and the effects of the curved part of the characteristic, as well as the influence of the input impedance on the amplitude response. The paper then describes methods of measuring the different characteristics of such receivers. It ends by giving an example of an instrument for routine testing. (Germany.)

Flat-Field Generator Speeds Color TV Testing, Richard W. Cook. "El." December 1957. 3 pp. Experimental work on color television systems is facilitated by generatory that provided composite color video signals of any hue and saturation as well as luminance signal that is variable from black to white. (U.S.A.)

Magnetic Tape Video Recording, F. Gallet. "Onde," Vol. 37, No. 365-366, August-September 1957. 8 pp. The first part of the article provides a comparison of the band width requirements for TV transmission in the USA, England, France, and the rest of Europe. Then the problems of the recording of video signals on magnetic tape are discussed. Finally, the magnetic tape TV recording technique developed by RCA, Bing Crosby, Inc., and Ampex are outlined. (France.)

Television Helps Engineers Solve Many Underwater Problems, W. M. Cameron. "Can. Elec. Eng." November 1957. 5 pp. During the last ten years considerable work has been done with underwater television in both salvage and inspection operations. It is proving an invaluable aid to the diver, particularly at depths greater than 350 feet where great pressure reduces his efficiency. This paper deals with a system developed by the NRC and describes some of the problems encountered in underwater research. (Canada.)

Comparison of Four Television Standards, R. D. A. Maurice. "E. & R. Eng." November 1957. 6 pp. The resolutions of four C.C.I.R. standard television systems are compared, some account being taken of the effects of the asymmetric sideband reception. The extent to which some of the distortions may be due to non-linearity of the phase-frequency characteristic is briefly mentioned. (England.)

The Measurements of the Reflection Coefficient in TV Transmission Lines and Equipment, E. Thinius. "Nach. Z." November 1957. 3 pp. A method is described which is suitable for measuring the magnitude and the phase of the reflection coefficient of equipment on a cable or of mismatch points in cables at operational frequencies. The whole frequency band is recorded by an oscilloscope so that points of major reflections can be detected immediately. (Germany.)

THEORY

On The Theory Of Optimum Control, N. N. Krasovskii. "Avto. i Tel.," No. 11, 1957. 11 pp. The paper poses the problem somewhat differently than heretofore. Instead of assuming that at each instant t during the transient response the values of the controlling quantities u/k (t) are limited, it is assumed that the limited quantity has a value which is determined, generally speaking, by the behavior of the function u/k (t) over the entire interval of the transient response. In addition to the case where the quantities u/k (t) are limited at each instant t, such a statement of the problem encompasses a number of other cases. An example of such a case is the problem of maximum speed of response when the average (in a definite sense) values of u/k (t) over the duration of the transient are limited. The method of solution provided in the article leads to results which are analagous to those which are obtained in other papers in corresponding cases. Certain sufficient conditions for the existence of optimum trajectories are provided, and methods for an approximate determination of such trajectories are described. (U.S.S.R.)

A Wide-Band Analogue Multiplier Using Crystal Diodes and its Application to the Study of a Non-linear Differential Equation, M. E. Fisher. "El. Eng." December 1957. 6 pp. The detailed design, construction and alignment of an inexpensive wide-band electronic analogue multiplier are described. Four-quadrant operation is obtained by the quarter-squares principle and each non-linear (squaring) unit employs twelve germanium diodes in the feedback loop of an operational amplifier (as in MacKay's designs). These units have an asymmetric quadratic characteristic and produce less than 1° phase shift at 50 kc/s. The output errors of a multiplier are less than 0.3 per cent of the maximum output. (England.)

An Analysis of Transient Response of Junction Transistor Amplifiers, J. C. Bhattacharyya. "J. ITE." September 1957. 7 pp. An exact solution of the one-dimensional diffusion equation as is applicable to a junction type of transistor has been obtained by the method of Laplace's transform. The solution has been utilized to derive an expression for the short-circuited output collector current with a step input forcing function. The time-independent part of this expression is found to be identical with the relation for steady state collector current as given earlier by Shockley. Experimental results on the transient response of Philips OC7O junction transistor have been shown to agree closely with the response obtained theoretically. It is concluded that under ordinary condition of operation the major physical process underlying transistor action must be the diffusion of minority carrier across the base region. (India.)

Interpretation of Network Theorems in Terms of Laplace Transforms, V. M. Narbutt. "J. ITE." September 1957. 6 pp. (India.)

The Problem Of Computing Integrals Of Functions With A Rapidly Varying Phase Over Finite Limits, V. P. Peresada. "Radiotek.," No. 9, 1957. 8 pp. A simple method is given for computing the integral of functions with a rapidly varying phase over finite limits (the stationary phase method). Approximate formulas are given for the values of the integral when one or several stationary phase points are present. A physical analysis of the stationary phase method is given when the method is applied to the computation of wave fields. An example is given in which the method is applied to computing the distortion of antenna directivity patterns when this distortion is associated with cubic phase distortion in the mouth of the antenna; computing formulas are provided. (U.S.S.R.)

Theory of the Helical Waveguide of Rectangular Cross-Section, R. A. Waldron. "J. BIRE." October 1957. 16 pp. The helical waveguide may be regarded as being formed by rotating a rectangle about a line, at the same time moving it parallel to the line. If the motion parallel to the line is omitted, the figure obtained is circular in form, but points which differ in azimuth by 2π are not equivalent, and infinite azimuthal angles become possible. This figure is called the infinite circular guide; it cannot exist physically, but for purposes of calculation may be taken as an approximation to the helical guide. (England.)

Approximation of the Natural Logarithm by a Power Law for use in Electro-Dynamic Problems, W. Rehwald and O. Zinke. "Arc. El. Uber.," Vol. 11, No. 10, October 1957. 6 pp. Transcendental equations containing logarithm and powers of an unknown quantity can easily be solved by an approximation which substitutes the function of the natural logarithm by a power law of the form Ax^{r}. This method is especially applicable to the propagation of electro-magnetic waves along a bare wire of finite conductivity or along a helical conductor. (Germany.)

The Dynamic Precision Of A Servo System Which Contains A Non-linear Member With A Polynomial Characteristic, S. Ia. Raevskii. "Avto. i Tel.," No. 11, 1957. 7 pp. The paper computes the mean-square error of a servo system with a non-linear member that has a polynomial characteristic. The perturbations are assumed to be stochastic. The mean-square error is computed by successive approximations on the basis of an approximate representation of the higher-order moments in terms of the lower-order ones. (U.S.S.R.)

Theory of Impulse Analysis and its Application to Servo-Mechanism, M. Cuénod. "Onde," Vol. 37, No. 365-366, August-September 1957, 23 pp. The first part of the article deals with the principle of input analysis. The author shows how to perform functional operations using the theory. In the second part of the article, some examples of the application of input analysis in the theory of servo-mechanisms are given. (France.)

Temperature Coefficients Of Frequency In Circuits With Optimum Thermal Compensation, M. E. Movshovich. "Radiotek.," No. 9, 1957. 6 pp. The paper derives equations which define the temperature coefficient of frequency in circuits with optimum thermal compensation. Results of computing a specific circuit are given, and it is shown that complex circuits exhibit no unconditional advantages over simple ones. (U.S.S.R.)

TRANSMISSION

Locks for Gas Pressurization, W. Steinmann. "Nach. Z." November 1957. 2 pp. The method and a device for a freely chosen sectionalization of a cable system with pres-

surized gas supervision into test sections. (Germany.)

The Computation Of Waveguides With Slowly Varying Cross-Sections, A. L. Gutman. "Radiotek.," No. 9, 1957. 9 pp. Expressions are derived which describe the elementary waves in a waveguide with a slowly varying cross-section. These expressions are utilized to derive the impedance and admittance conversion formulas for such a waveguide, as well as to determine the external parameters of a four-pole which is equivalent to a waveguide section with a slowly varying cross-section. An integral equation is obtained which defines the longitudinal profile of the waveguide couple which produces the minimum distortion (i.e., a section of waveguide with a slowly varying cross-section). (U.S.S.R.)

Waveguide Design for Die-Casting, P. Humphreys. "E. & R. Eng." December 1957. 6 pp. This article explains how components which have been designed in normal rectangular waveguide may be easily modified on a theoretical basis to make them suitable for die-casting manufacturing methods. The theory is applicable to cases where the waveguide can be manufactured by splitting it along the length of the central E-plane and the unit is therefore cast in two halves. (England.)

Vibration of a Special Mechanical System which has Masses Arranged in the Form of a Pascal Triangle, T. H. O'Callaghan. "Freq.," Vol. 11, No. 9. September 1957. 11 pp. This article emphasizes a rather special mechanical system with rather interesting characteristics which can be mathematically evaluated quite easily. By proper selection of the spring constants F_r between neighboring masses, a system can be created in which the square of the resonance frequency Ω 2/s represents an arithmetic series. In addition, the difference in amplitudes between neighboring vibrating masses is constant for all resonance frequencies. Numerical examples are given. (Germany.)

TUBES

Selection and Application of Traveling Wave Tubes—II, N. Hansen and A. Nielsen. "El. Des." December 1, 1957. This concluding part deals with the design of solenoids and power supplies associated with traveling wave tubes. Part I presented the procedures in selecting proper operating performance of a TWT and the most suitable circuit design, together with a discussion of the practical problems associated with designing and packaging a traveling wave amplifier. (U.S.A.)

Developmental Position and Method of Operations of Microwave Tubes, III, R. Muller and W. Stotter. "El. Rund." December 1957. 6 pp. In this part of the article series types of transit-time tubes are dealt with. The retarded-field tubes which are of minor importance today compared to other type transit-time tubes are briefly considered. Klystron amplifiers and oscillators with a power range between a few milliwatts and several megawatts are described in more detail. The reflex klystron used as a modulator is of particular importance. Power and efficiency of this tube are of minor importance than the quality of the modulation characteristic linearity. (Germany.)

Simple Description of the Basic Principles of Cathode Ray Tubes III, V. Gaty. "Radio Rev." Vol. 9. No. 9. September 1957, 2 pp. This is the third part of an article on cathode ray tubes. Described are the construction of the split beam design by Cossor, as well as the iron trap principle. (Belgium.)

Applications of a New Type of Cold Cathode Trigger Tube, Part 3, G. O. Crowther and K. F. Gimson. "El. Eng." December 1957. 6 pp. (England.)

Metal Ceramic Tubes to Withstand 500 C and High Vibration, J. H. Wyman and R. H. Kuhnapfel. "El. Des." December 15, 1957. 4 pp. (U.S.A.)

PATENTS

Complete copies of the selected patents described below may be obtained for $.25 each from the Commissioner of Patents, Washington 25, D. C.

Time Discriminator, #2,814,725. Inv. J. E. Jacobs and E. E. St. John. Assigned Hughes Aircraft Co. Issued November 26, 1957.

The plate of a first tube is connected by a resistance to the cathode of a second tube, providing the output. Respective control pulses are applied to the grids of the tubes, the signal pulses supplying the plate voltages for both tubes and being applied between the cathode of the first tube and the plate of the second tube. Conduction occurs only at coincidence of the signal and control pulses. Thus the output error signal is indicative of the difference in the conductive periods of the tubes.

Semiconductor Device, #2,814,735. Inv. W. R. Cady and J. E. Mulhern. Assigned General Electric Co. Issued November 26, 1957.

The rectifier comprises a P-N junction, two opposing contacts to the two zones, respectively, being connected as diode terminals. An electric field transverse to the current flow between the two opposing contacts is established between third and fourth contacts, both to the second zone. The third contact is positioned close to the P-N junction, while the fourth contact is positioned remote therefrom. Conduction carriers are directed towards the fourth contact by a suitably polarized field.

Television System, #2,814,757. Inv. H. E. Beste. Assigned Allen B. Du Mont Laboratories. Issued November 26, 1957.

The beam intensity controlling signal is in turn controlled by a signal depending on the instantaneous position of the electron beam. A center tapped transformer generates a waveform having a basic frequency depending on the instantaneous scanning speed of the beam. The faceplate of the cathode ray tube has an integrally molded continuous sinuous glass rib on the inner surface projecting above the surrounding glass surface.

Photoelectric Color Converter for Cathode Ray Tubes, #2,814,670. Inv. R. C. Templin. Issued November 26, 1957.

A screen produces ultraviolet radiation in response to a scanning electron beam. The ultraviolet radiation irradiates a photoemissive cathode positioned in close proximity to the screen, the electrons emitted by the cathode being attracted towards at least to fine-mesh anodes arranged close to the cathode and coated with different-color fluorescent material, respectively.

Noise Pulse Interruption of Synchronizing Signal Separator, #2,814,671. Inv. R. Adler. Assigned Zenith Radio Corporation. Issued November 26, 1957.

The phase-inverted composite television signal is applied to the second self-biased control grid of a tube, a virtual cathode being established in the vicinity of this second control grid. Noise pulses exceeding the synchronizing signal level tend to overbias the grid and to render the tube unresponsive to a succeeding synchronizing-signal component. The composite video signal is applied to the first control grid of the same tube, biased to pass the composite television signal but to inhibit electron flow in response to the noise impulses. This prevents the overbias of the second control grid, resulting in an output signal representative of the synchronizing-signal component only.

Microwave Ovens, #2,814,708. Inv. J. Blass. Assigned Raytheon Manufacturing Co. Issued November 26, 1957.

The top wall of an initially rectangular cavity is supplied with tapered surfaces interconnecting the top wall with all adjacent walls and so positioned with respect to the propagating waves that they are reflected towards a region to be heated.

Signal Converter, #2,815,487. Inv. A. B. Kaufman. Assigned Northrop Aircraft, Inc. Issued December 3, 1957.

The d.c.-a.c. converter supplies the signal to two series-connected phototubes, one of which extends between the two input terminals of an a.c. amplifier. The two phototubes are alternately irradiated with light at the frequency of the desired a.c. signal.

Apparatus for Coupling a Helical Conductor to a Microwave Field, #2,815,489. Inv. B. A. Dahlman. Assigned Radio Corporation of America. Issued December 3, 1957.

The hollow pipe coupling wave guide is subdivided into a plurality of sub-guides containing delay circuits, introducing different delays. A conductive helix is partially arranged in energy transferring relation with the sub-guides, the interacting section of the helix being designed to be suitably related to the differences in delay in the coupling subsections.

Magnetic Memory Channel Recirculating Systems, #2,815,498. Inv. F. G. Steele. Assigned Digital Control Systems, Inc. Issued December 3, 1957.

Consecutive binary digit values in an initial electric signal are converted into magnetized cells, magnetized in one direction for one digital value and in the opposite direction for the other digital value, on a moving magnetic channel. The reconversion to electrical signals is effected by a system sensitive to changes in direction of magnetization of the moving magnetic channel.

Synchronizing Signal Generator, #2,815,456. Inv. A. N. Ormond. Issued December 3, 1957.

Synchronizing signals coinciding with the peak values of a periodic input signal are derived by a special network. The input is connected across a series connected rectifier-capacitor branch and a series-connected rectifier-resistor branch, the two branches being connected in parallel. The non-common rectifier terminals are connected by a third rectifier in series with a resistor. The output is supplied by the two-rectifier-resistor terminal.

Electron Discharge Device, #2,815,464. Inv. W. W. Wright, P. Welch and D. A. Day. Assigned International Standard Electric Corp. Issued December 3, 1957.

A high conversion conductance, high conversion impedance frequency-converter tube comprises a common cathode triode and heptode in one envelope. The heptode is further provided with a signal grid, a local oscillator injection grid connected to the triode grid, and three interconnected screen grids, one intermediate the two grids, one closely adjacent the injection grid, and one adjacent the heptode anode.

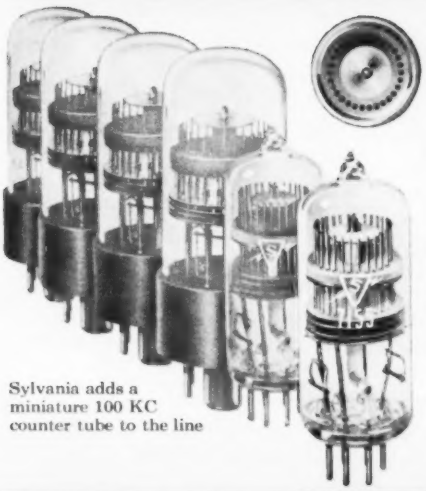
Traveling Wave Tube, #2,815,466. Inv. S. Sensiper. Assigned Hughes Aircraft Company. Issued December 3, 1957.

A ferromagnetic attenuating structure surrounds the slow-wave structure of the traveling wave tube. A plurality of elongated ceramic ferrite bodies extending perpendicular to the tube axis alternate with elongated ferromagnetic bodies extending parallel to the tube axis. The permeability of the ferromagnetic bodies greatly exceeds that of the ceramic ferrite bodies.

MICROWAVE AND SPECIAL TUBE NEWS from SYLVANIA

MINIATURE COUNTER TUBES...

New 100 KC counter tube, type 7155, is introduced by Sylvania for smaller, lighter counting devices



Sylvania adds a miniature 100 KC counter tube to the line

High-speed counter tube with three output cathodes in a T 5½ envelope is now available from Sylvania. The new tube, type 7155, is of particular value in equipment design where size and weight are important factors. This latest addition to the counter tube line follows by less than a year Sylvania's development of the first 100 KC counter tube.

Type 7155 operates with the reliability, accuracy and simple circuitry typical of all Sylvania counter tubes. As with the other high-speed tubes in the line, types 6909 and 6910, the new counter tube can be used singly or cascaded in multiple stage counting for laboratory or industrial applications.

Circle No. 121 on INQUIRY CARD

RATINGS (Absolute Values)

Total Anode Current	0.7 Ma 1.2 Ma	Min. Max.
Voltage Between Electrodes (Other than Anode)	140 Volts	Max.
Supply Voltage (Anode to Cathode)	425 Volts	Min.
Input Frequency	100,000 P.P.A.	Max.

COAXIAL TR TUBES...

Sylvania develops new TR construction—a coaxial tube for low frequencies

New coaxial TR tube saves space and weight at low frequencies

TR tubes in coaxial construction for low frequency radar and countermeasure equipment are now in production at Sylvania. Typical of the new tubes available is the TR860, a 9-inch diameter type designed for very high power. It utilizes one of the largest ceramic-to-metal seals in existence.

The new coaxial construction is based on four years of research and development work by Sylvania. One of its major advantages over conventional rectangular TR's at low frequencies is the great saving in space and weight it makes possible. In addition, the new coaxial tubes are much more rugged than conventional types because of smaller window and seal areas.

Circle No. 122 on Inquiry Card

NEW MICROWAVE CRYSTAL DIODES...

Double-ended construction adds new convenience to S and X band crystal diodes

Sylvania's new dual duty microwave crystal diodes utilize detachable spring-grip base

New Sylvania microwave crystal diodes in the S and X bands can now serve as either forward or reverse diodes. A detachable spring-grip base can be slipped on either end for forward or reverse use.

The dual diodes eliminate the need to specify reverse types and simplify ordering and stocking.

Designations for the new double-ended diodes are 1N416B, C, D and E for 1N21 types and 1N415B, C, D and E for the 1N23 series.

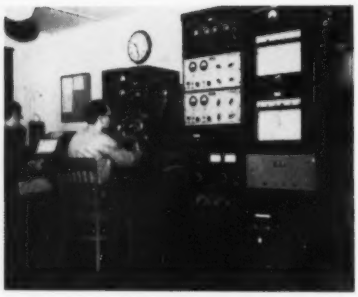
Circle No. 123 on INQUIRY CARD

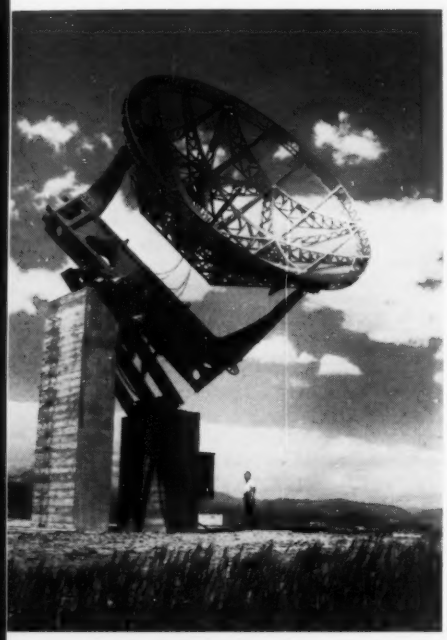
SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Building, Montreal

SYLVANIA

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

Sun Watch For IGY





This radio forecasting center (r) at Fort Belvoir, Va., coordinates data on solar disturbances and issues worldwide alerts.

Each day this radio telescope (l) tracks the sun for signs of unusual solar activity.

Normal solar activity is often interrupted by tremendous storms or flares sweeping out into space.

At Boulder, Colorado, two radio telescopes track the sun in its daily path across the sky for signs of such disturbances. The two telescopes operate at different frequencies so they can gather information at two different distances from the sun's surface.

Information regarding the state of the sun is then sent to the IGY World Warning Agency at the Fort Belvoir radio forecasting center of NBS. Incoming teletype messages bring data from many points regarding disturbances on the sun or in the earth's atmosphere.

When this data warrants, messages are sent to warn IGY scientists stationed all over the world so they can increase their observations of geophysical phenomena. Our photograph of the warning center shows the teletype, radio direction finding equipment, and equipment used to record intensity of signals from distant broadcasts.

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complicated for our engineers . . .
Your specific need may be one of our more than 100 standard units, a telescopic tilt-over (up to 168 ft.) or a modified version of either type. Simply send our engineers your required height, antenna load, wind load, other specifications and your tower will be engineered and erected in record time.
We specialize in H-type, trilon, twin-type, crank-up, tilt-over and special designs for TV, AM and FM broadcasting, Ham, two-way communication and microwave... guyed or self supporting.
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New Products . . . for the Electronic Industries

LONG LIFE CAPACITORS

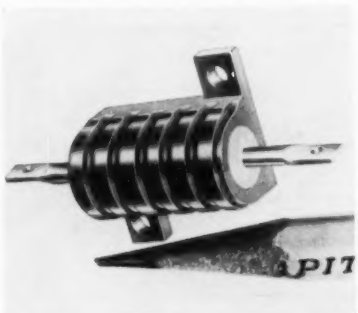
Designed to have a life expectancy in excess of 10 years, the new Type UPB Twist-Prong Electrolytic Capacitors will find wide application in high-reliability electronic equipment. Intended primarily for bypass and

low-frequency filter applications, Type UPB's are available in single sections with dc voltage ratings from 6 to 450 v., and in capacity values from 2000 to 20 mfd. Dual sections are available with dc voltage ratings from 150 to 450 v. and in capacities from 10-10 to 50-50 mfd. Triple sections from 20-20-20 to 50-50-50 mfd. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle 213 on Inquiry Card, page 97

MINIATURE RESISTOR

The sub-miniature 10 w. powerhouse resistor provides precision resistance, high power capacity and good heat dissipation. Resistor is available in tolerances of ±0.05% to ±3% with a range from 0.05 ohms to

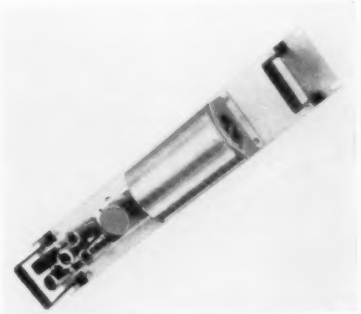


30,000 ohms, depending on tolerance specified. When panel mounted on aluminum, the RH-10 will dissipate 10 w., derating to 0 at 275°C. Conservative wattage rating in free air is 6 w. The entire resistor element is ruggedly constructed with welded termination throughout. Element is suspended in a special shock absorbing compound. Dale Products, Inc., Columbus, Neb.

Circle 215 on Inquiry Card, page 97

CRYSTAL OVEN

Oven temperature variation is held to 1/1000 of the ambient temperature change in a new Proportionally-Controlled Crystal Oven now available. Called the RD-130, the complete unit consists of two compact assemblies—



a thermo-oven, which accommodates an HC-6/U crystal holder, and an oven control amplifier—both mounted on a 3½ in. H standard 19 in. relay-rack panel, but with sub-assembly packaging arrangements available as needed. The oven is usable over the military environmental temperature range. Manson Labs., Inc., Dept. G, P. O. Box 594, 207 Greenwich Ave., Stamford, Conn.

Circle 217 on Inquiry Card, page 97

DIGITAL RECORDER

The Model 560A Digital Recorder prints 11 column digital information at rates to 5 prints/sec. Although primarily designed to make a permanent record of electronic counter readouts, it can be used with two or more counters simultaneously, digital voltmeters, time recorders, flowmetering equipment and systems such as telemetering installations and engine test stands. In addition it provides an

analog current or voltage output to drive a galvanometer or potentiometer strip chart recorder or to provide a servo control. Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle 214 on Inquiry Card, page 97

METAL FILM RESISTORS

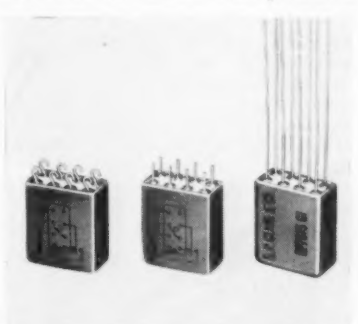
Molded metal film resistors are available. The line has been increased to include 5 sizes—⅛, ¼, ½, 1 and 2 watts. They offer high stability with low and controllable temperature coefficients, and will withstand full load at 125°C ambient. Units have a metallic resistive film firmly bonded to a specially compounded ceramic core. Intended for applications where high reliability is necessary, and a low con-

trolled temperature coefficient is required. Also, for applications of low inductance and/or shunt capacitance. International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle 216 on Inquiry Card, page 97

SEALED RELAYS

A new hermetically sealed relay no bigger than a postage stamp is available. The Type F Relay is designed to fill the demand for a smaller, lighter relay stalwart enough to withstand extremes of temperature, heavy shock and vibration, yet fast and more than moderately sensitive. Rated for ambient temperatures from −65°v to +125°C, it is tested for shock of 50 Gs for 11 msecs. Pickup time is

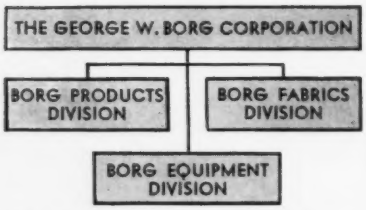


3.5 msecs. nominal; drop-out time 1.5 msecs. nominal. Contact rating is for 3 a. resistive at 28 vdc or 115 vac. C. P. Clare & Co., 4101 Pratt Blvd., Chicago 45, Ill.

Circle 218 on Inquiry Card, page 97

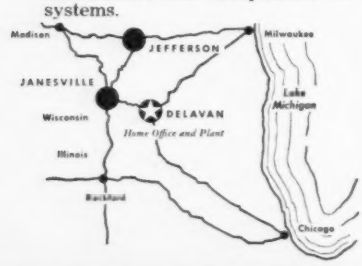
WHO IS BORG?

George W. Borg, who founded this corporation, is the "Mr. Clutch" who started with Borg & Beck. He then helped organize the Borg-Warner Corporation of which he became president. Later he served as chairman of the board until he resigned to devote his full attention to The George W. Borg Corporation.



The George W. Borg Corporation is comprised of three divisions

- **Borg Products Division**
  Manufactures automotive clocks.
- **Borg Fabrics Division**
  Manufactures deep-pile fabrics best known of this line is the fashionable "Borgana" fabric.
- **Borg Equipment Division**
  Manufactures Micropots (precision potentiometers), Microdials (precision turn-counting dials), instrument motors, frequency standards, aircraft navigational instruments and components for systems.



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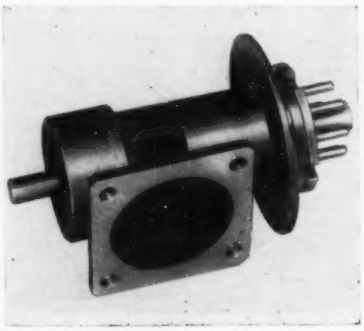
New Products

REFLEX KLYSTRON

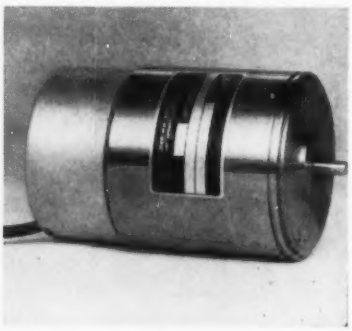
New reflex klystron features low voltage operation over the 8.5-10.5 kmc band. Type SRX-92 oscillator is designed for low hysteresis and high thermal stability. Applications include local oscillator in microwave receivers and spectrum analyzers, signal source in radar test sets, and low power oscillator for microwave bench work. Using electrode voltages under 300v, it produces 20 mw minimum output. Minimum bandwith of electronic modes is 35 mc. The 2000 mc range is covered in 5 turns of the tube's single-screw integral tuner. Sperry Gyroscope Co., Great Neck, N. Y.



Circle 227 on Inquiry Card, page 97

HIGH ACCURACY SYNCHRO

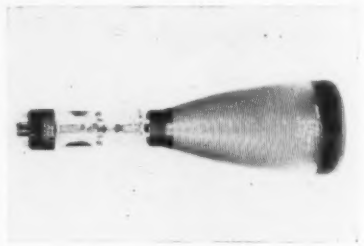
The development of a high accuracy synchro component having a maximum error from electrical zero of only a half minute has been announced. A resolver type unit, this synchro is capable of functioning as a 4-wire control transmitter, control differential transmitter, or control transformer which when used in a 4-wire string to form a typical data transmission system, holds overall system error to less than one minute from electrical zero. The unit may also be modified for operation at either 4000 or 10,000 cps. Kearfott Co., Inc., 1378 Main Ave., Clifton, N. J.



Circle 229 on Inquiry Card, page 97

C-R TUBES

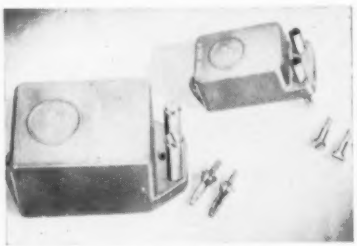
Known as EIA Type 5BGP—(T51P) and 5BHP—(T54P), the tubes have 5 in. flat round faceplates, employ both electrostatic focus and deflection, and incorporate post acceleration by use of a spiral band resistance winding which extends from tube faces to the vicinity of the deflection plates. They are completely interchangeable with the T51P and T54P. Type 5BGP—is 17½ in. overall length, while Type 5BHP—is 18¼ in. Both tubes available with P1, P2, P7 or P11 fluorescent screens. Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.



Circle 228 on Inquiry Card, page 97

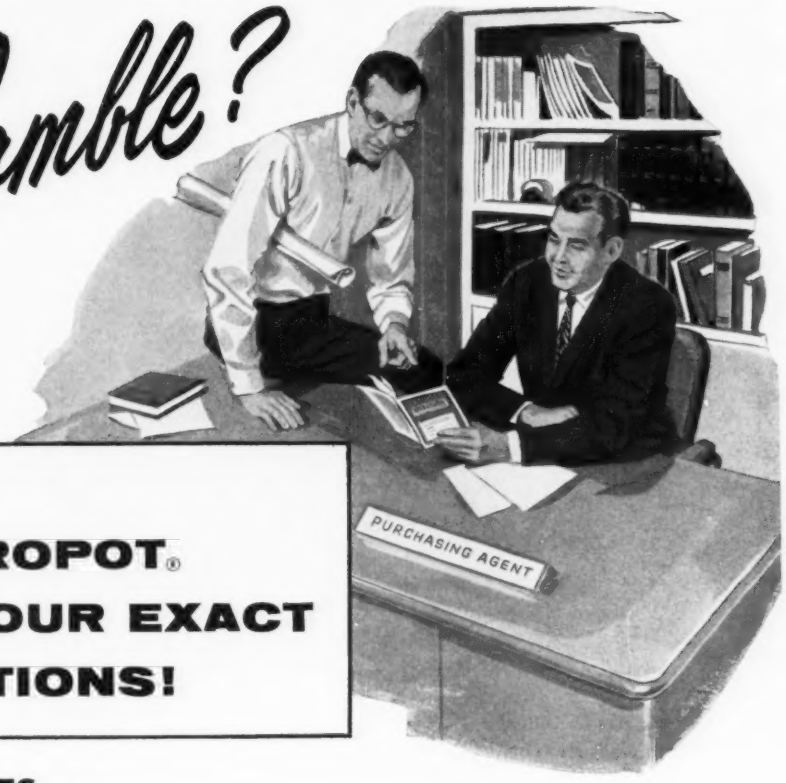
MICA CAPACITORS

High-quality silvered-mica sheets, the same material as is used in the 0.1% Type 1409 Standard Capacitors, are now used in Type 505 Capacitors. Although using the same construction as the standard capacitors, the Type 505's are adjusted to ±0.5% and are packaged in a less-expensive case. They are available in a 1-2-5 series extending from 100 μμf to 0.5μf. They are housed in low-loss molded-phenolic cases and are equipped with both screw- and lug-type terminals and mounting flanges. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.



Circle 230 on Inquiry Card, page 97

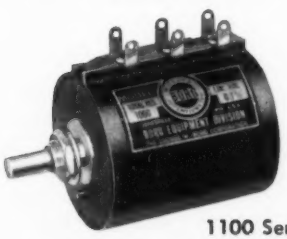
Why Gamble?



THERE'S A BORG MICROPOT® TO MEET YOUR EXACT SPECIFICATIONS!

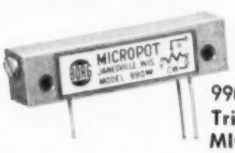
BORG MICROPOTS... the Ultimate in Multi-Turn Precision Potentiometers

Borg offers a complete line of high-precision, linear potentiometers called MICROPOTS. Precision is Borg's business . . . that's why MICROPOTS offer so many exclusive advantages. Superior design and production methods make Borg MICROPOTS available in any quantity. Write today for the name of your nearest Borg Jobber or "Tech-Rep."



1100 Series MICROPOTS

A precision MICROPOT that offers your products a price advantage in today's competitive markets. Lug or lead type terminals. Accurate . . . dependable . . . long lived.

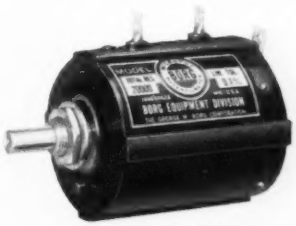


990 Series Trimming MICROPOTS

Small in size, lightweight, rugged and dependable. Three types of terminals . . . printed circuit, solder lugs or insulated wire leads.

900 Series MICROPOTS

Standard ten-turn and three-turn models to fit most special design needs. Extremely accurate and dependable under adverse environmental conditions including severe vibration and shock.



205 Series MICROPOTS

A quality MICROPOT. Designed for both military and commercial applications. Proven in many different mobile and stationary types of electronic circuitry.

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This advanced "slide-rule" is a highly accurate device that permits engineering or research personnel to simulate equations or physical problems electronically, and save many hours of involved calculation.

Ideal for industry, research, or instructional demonstrations. Incorporates such features as:

- 30 coefficient potentiometers, each capable of being set with extreme accuracy.
- 15 amplifiers using etched-metal circuit boards for quick assembly and stable operation.
- A nulling meter for accurate setting of computer voltages.
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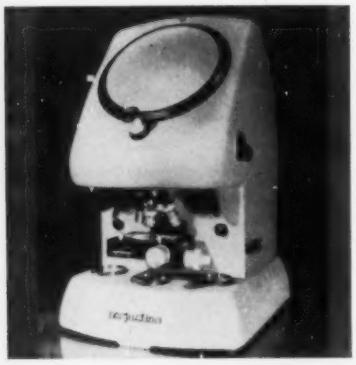
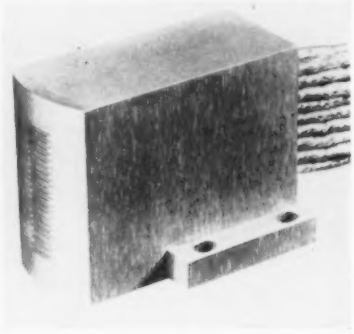


Circle 231 on Inquiry Card, page 97

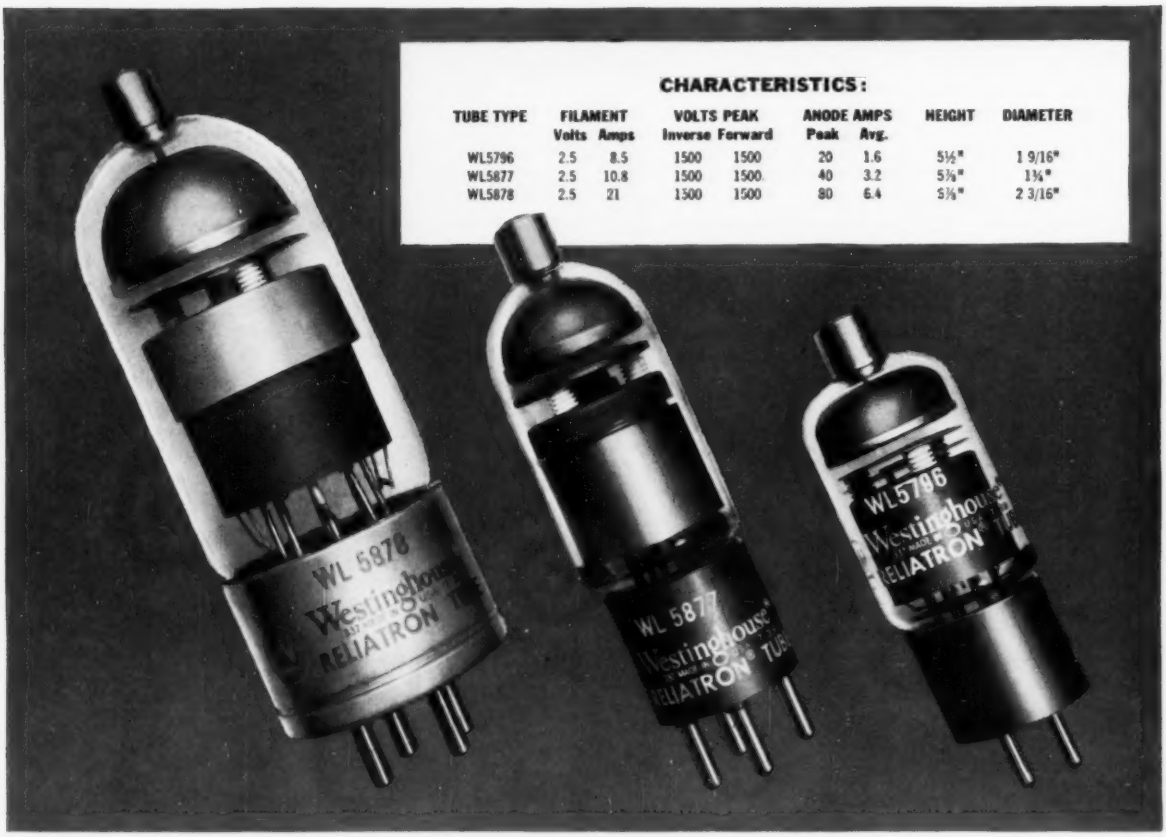
RECORDING HEADS

A new, all metal, 20 channel universal recording head has been added to the GTW line. Unit can be used to record 20 channels of audio or digital information on a 1 inch tape. All metal construction assures longer life and eliminates tape oxide build up. The new unit incorporates higher efficiency design, precision lapped gap and full shielding between channels. General Transistor Western Corp., 6110 Venice Blvd., Los Angeles 34, Calif.



Circle 232 on Inquiry Card, page 97

New Xenon-filled Westinghouse THYRATRON TUBES fit 90% of new equipment needs!


CHARACTERISTICS:
TUBE TYPE | FILAMENT Volts Amps | VOLTS PEAK Inverse Forward | ANODE AMPS Peak Avg. | HEIGHT | DIAMETER
WL5796 | 2.5 8.5 | 1500 1500 | 20 1.6 | 5½" | 1 9/16"
WL5877 | 2.5 10.8 | 1500 1500 | 40 3.2 | 5⅞" | 1¾"
WL5878 | 2.5 21 | 1500 1500 | 80 6.4 | 5⅞" | 2 3/16"
WL 5878
Westinghouse
RELIATRON
WL 5877
Westinghouse
RELIATRON
WL5796
Westinghouse
RELIATRON

Compact new design saves space, gives superior performance and uniform quality!

For motor controls, firing ignitrons, inverter service or any other new industrial or military equipment need—you'll find new Westinghouse Thyratrons the most advanced you can use. They meet NEMA and EIA specifications for control applications and have the following characteristics:

- 12 to 1 peak to average anode current rating.
- 1,500 volt forward and inverse voltage rating.
- 15 second averaging time.
- Operate in broad ambient temperature limits (−55° to 70°C)
- Fast cathode heating time.
- Small compact construction.

YOU CAN BE SURE...IF IT'S

Westinghouse

Electronic Tube Division Elmira, N. Y.

To see how Westinghouse Thyratrons can fill your design requirements, write today for detailed data. Westinghouse engineers will be glad to consult with you, if you wish. Sample orders available for immediate shipment.

CLIP AND MAIL COUPON NOW

COMMERCIAL ENG. DEPT., ELECTRONIC TUBE DIV.
WESTINGHOUSE ELECTRIC CORP. Elmira, N. Y.

Please send me full information on the following Thyratron Tube (s):

—WL5877 —WL5878 —WL5796

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

Circle 74 on Inquiry Card, page 97

What "Moves" Engineers?

By A. S. KAPLAN

Petrik & Stephenson Adv. Agency

The number of specialists coming into engineering fields at this time is small even for normal industry growth conditions. There are a number of reasons for this sharp off-balance supply and demand picture. Basically, however, there are three:

First: The college-age group is small due to the predepression birth rates of the 1930's. This year's engineering graduates number about 34,000. Immediate use of this total is curtailed by an estimated 11,000 engineers committed to military duty upon graduation, leaving only approximately 23,000 engineers to bridge the gap. Best estimates place the need at 58,000 new engineers annually.

Second: Because of the lack of industry (as well as general) foresight as to future industry needs, plus "bad advice" a few years back (to prospective students) helped strengthen the already prevalent concept that engineering "was not the field to be in."

Third: Going deep into the root of this problem we find the ultimate solution for the industry over the long pull will be in our educational setup. This is an all-inclusive undertaking that is gradually being remedied. According to a recent survey, engineering enrollments in technical schools rose between the years 1951 and 1955 from 166,000 to 243,000. This is a good start, but for all present intents and purposes, just a start.

The current out of balance situation on supply and demand of specialists in the electronics and nucleonics and allied fields poses special problems in the recruitment of engineers and technicians.

"Recruitment" is really no longer the right word

(*Continued on page* 138)

Following were the motivation factors in order of importance:

To the Engineers:

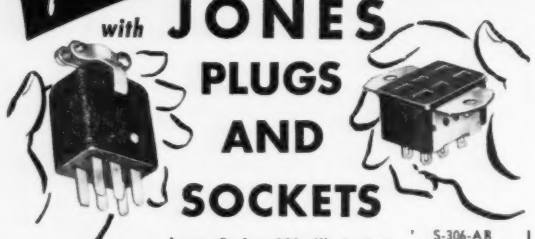
1. Higher Salary—29%
2. Greater Responsibility—27%
3. Geographical Consideration—19%
4. Opportunity for Advanced Study—6%
5. Work for Larger Company—6%
6. Work for Smaller Company—5%
7. Company Reputation and Policy—3%

To the Companies:

(their view of why an engineer seeks a new job):

1. Greater Responsibility—29%
2. Geographical Consideration—18%
3. Higher Salary—15%
4. Interesting Type of Work—9%
5. Work for Smaller Company—9%
6. Opportunity for Advanced Study—8%
7. Company Reputation and Policy—6%
8. Work for Larger Company—3%

INSURE *Proven Quality* with JONES PLUGS AND SOCKETS



P-306-CCT Plug, Cable Clamp in Cap

Jones Series 300 Illustrated. Small Plugs & Sockets for 1001 Uses. Cap or panel mounting.

S-306-AB Socket with Angle Brackets.

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- Bar type Plug contacts brass, cadmium plated, with cross section of 5/32" by 3/64".
- Installation molded bakelite.
- All Plugs and Sockets polarized.
- Metal Caps, with formed fibre linings.
- Made in 2 to 33 contacts.
- For 45 volts, 5 amperes. Efficient at much higher ratings where circuit characteristics permit.

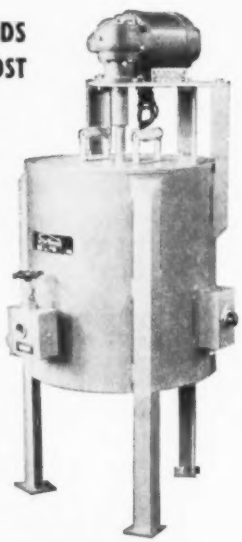
Ask for Jones Catalog No. 21 showing complete line of Electrical Connecting Devices, Plugs, Sockets, Terminal Strips. Write or wire today.

Jones

HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

Circle 92 on Inquiry Card, page 97

MELT COMPOUNDS AT LOW COST



This Sta-Warm compound melter, model Y, with selective temperature control, heated gate valve and power driven agitator makes simple work of melting a wide variety of industrial compounds *economically, uniformly, dependably.*

Capacities from 5 to 2000 gal. Voltages to 550-v. Widely used and preferred because of its high efficiency in heating critical materials without burning and also without leaving cold unheated lumps to clog outlet.

Ask for complete catalog literature today on this and on other Sta-Warm melting equipment. No obligation.

"If You Can Wrap a String Around It, Sta-Warm Can Heat It for You."

Sta-Warm ELECTRIC CO.
222 N. CHESTNUT ST., RAVENNA, OHIO
Subsidiary of ABRASIVE & METAL PRODUCTS CO.

Circle 93 on Inquiry Card, page 97

Industry News

Robert P. Crago, Dir. of Eng. of the Military Products Div. of IBM, has been named Outstanding Young Electrical Engineer of 1957 by Eta Kappa Nu Assoc. Honorable mention to **Dr. Walter R. Beam,** Mgr. of Microwave Advanced Development, RCA, and **Glenn W. Stagg,** Sr. Engr., American Gas and Electric Corp.

Albert J. Harcher has joined Clevite Transistor Products as Production Manager. Mr. Harcher was formerly associated with CBS-Hytron.

Frank Randall has been appointed to the position of President of Amperex Electronic Corp.

F. Randall

F. Speaks

Fred Speaks has been named to the position of Assistant Director of Marketing for Research and Development for Eitel-McCullough, Inc.

Russell M. Alston has been elected Vice President in charge of manufacturing for Conrac, Inc.

T. C. Wisenbaker has been named Assistant Division Manager of the Missile Systems Div. at Raytheon Mfg. Co.

Samuel B. Fishbein has assumed the duties of Assistant General Sales Manager of the Military Operations Dept. at A. B. Du Mont Labs., Inc.

Sylvan E. Branklin is now Manager of the Industrial Reactor Development Group of Control, a division of Magnetics, Inc.

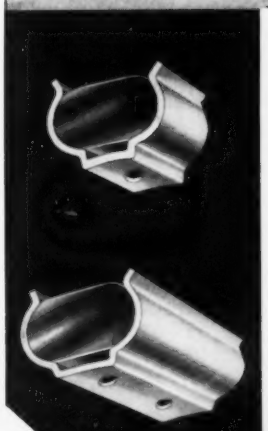
Robert C. Bickel has been promoted to the position of Sales Manager of Andrew Corp.

Joseph P. Baker has joined Magnetic Research Corp. as National Sales Manager. Mr. Baker formerly headed magnetic amplifier sales for Westinghouse Electric Corp.

Percy L. Spencer has been elected Senior Vice President of Raytheon Manufacturing Co. He will continue as Manager of the Microwave and Power Tube Div.

(*Continued on page* 134)

AUGAT'S NEW TRANSISTOR CLIPS



Augat Brothers have developed a new line of clips for the retention of transistors, crystals, diodes, etc.

Now available in all standard sizes, they are the answer to the engineers' layout problems in regards to shock and vibration. Made of either 1065 spring steel or 25 alloy beryllium copper to retain shape, a minimum of clamping action is lost in use.

If your requirements are not listed in our catalog, write us for information on clips made to your specifications.

AUGAT BROS. INC.

31 PERRY AVENUE • ATTLEBORO, MASS.

Circle 76 on Inquiry Card, page 97

NOW POSSIBLE...

instant construction of Shielded cables with

NEW! SHIELDED AUTHENTIC Zippertubing

Three ranges of shielding available; light-aluminum, medium-lead, heavy duty-magnetic foil.

FEATURES:

- Pure metal foil now laminated to the inner surface of Zippertubing for immediate shielded cable.
- Shielded cable at a fraction of the cost of the conventional tin-copper shielding, plus outer jacket.
- Permits emergency and maintenance repair modifications in the field.
- Both high & low frequencies are shielded up to six gausses with attenuation result up to 1200:1 at 250MC.
- Offered with overlap construction for 100% coverage protection.
- May be stored in flat form with sizes from ½" I.D. up.

A strong, durable, yet flexible shielded cover can be applied in minutes. With Shielded Zippertubing a manufacturer can create his own shielded cable at a fraction of the cost and approximately 1/10 of the delivery time. The normal time and labor spent in encasing cables and wire harnesses can be reduced by as much as 90%. No special equipment necessary.

SPECIFICATIONS:

Wall Thickness: .020, .040, .060 AWG

Material: Plastic saturated fiber glass backed material laminated to various metal foils.

Put-Up: Available in 25 to 300 foot rolls. Longer lengths available upon specification.

Sizes: 3/16" I.D. up, in increments of 1/16", ± 1/64".

Colors: Gray. Other colors available on special order.

Zippertubing MANUFACTURED BY

THE ZIPPERTUBING CO.

752 So. San Pedro Street, Los Angeles 14, Calif., Michigan 0831

Circle 77 on Inquiry Card, page 97

NOTICE TO SUBSCRIBERS

A change of address requires four weeks notice. Please notify the Circulation Department, ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Philadelphia 39, Pa., as early as possible. Include, if you can, the imprinted strip on the magazine wrapper showing exactly how it is now addressed. This will enable us to put the change into effect with a minimum of delay. Also, please notify your local postmaster.

THE PUBLISHER ASKS

a favor from you who are users of our Annual June Directory issue. If you're one of the many who prefer the ELECTRONIC INDUSTRIES' directory issue to similar product-finding guides of other publishers, will you write and tell us why you prefer ours? Your letter will be shown to advertising men all over the United States. Your testimonial is as important to us as a sports or show business celebrity's would be to a consumer product. Can you spare a minute to write us a few lines?

ELECTRONIC INDUSTRIES

Chestnut & 56th Sts.
Philadelphia 39, Pa.

Industry News

(*Continued from page* 133)

Charles W. Carmody has been appointed to the new position of Assistant Director of the Office of Air Traffic Control, Civil Aeronautics Administration.

Donald S. Parris is now Director, Electronics Division, Business and Defense Services Administration.

William J. Kleinknecht, General Superintendent of the American District Telegraph Co. will now serve as Assistant Director of the Communications Div. of the Business and Defense Services Administration.

Vincent A. Van Praag has become Director of Marketing for Packard-Bell Computer Corp.

Carl Neisser will now serve as Manufacturing Manager for the Systems Div. of Beckman Instruments, Inc.

Dr. Ernst Steinhoff has assumed the duties of Associate Technical Director at Aerophysics Development Corp.

Walter Landry has joined Electronic Communications, Inc. as Director of Quality Control. Mr. Landry previously served as a Quality Control executive with Hughes Aircraft Co.

Raymond Marcel Gut Boucher has joined Gulton Industries, Inc. as head of its new research program on the effects of ultrasonic energy in air. Mr. Boucher was formerly a scientific consultant to the French Air Ministry.

R. M. G. Boucher

J. F. Degen

Joseph F. Degen is the new Vice President in charge of manufacturing for Weston Electrical Instrument Corp. Mr. Degen was formerly Manufacturing Superintendent for I.B.M. Corp. at its Poughkeepsie plant.

Beverly Paxson has joined Donner Scientific Co. and has been placed in charge of computer applications. Mrs. Paxson joins Donner after serving with the computer group of Beckman Instruments.

Charles M. Heiden has assumed the duties of Manager of the Research Application Dept. at the General Electric Research Laboratory.

Maj. Gen. Albert Boyd, USAF (Ret.), has joined Westinghouse Electric Corp. as Consultant and Advisor to the general manager of defense products.

H. Steven Berck has been named Manager of Distributor and Export Sales of Motorola's Semiconductor Div. **Joseph A. Gentile** is now Manager of Marketing Administration.

Gerald R. Sauer will now serve as a newly created position of Manager, "Sage" Powerhouse Operation for Radio Corporation of America at Topsham, Maine.

R. T. Silberman will now serve as President of Kin Tel Div., Cohu Electronics, Inc.

R. T. Silberman

J. W. Haanstra

John W. Haanstra has been named Assistant Manager of Product Development in charge of all development programs and International Business Machines Corp.

James F. Toole will now serve as Treasurer and **Charles Ondrick** as Controller for Sperry Rand Corp.

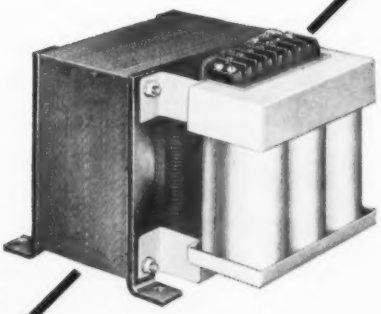
Walter W. Finke has been elected Vice President of Minneapolis-Honeywell Regulator Co. Mr. Finke continues as President of Datamatic.

William J. Nagy is now General Sales Manager of Philco Corp's Accessory Division.

Benedict V. K. French has been appointed Sales Engineer of Circuit Instruments Inc., a subsidiary of International Resistance Co.

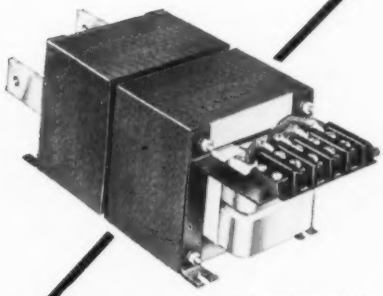
Robert G. Marchisio becomes Vice-President and General Manager of semiconductor operations and **Michael Callahan,** Vice-President and General Manager of receiving tube operations with the separation of activities of CBS-Hytron.

Voltage Stabilizers . . . . .



Input 190/208/230 volts ± 10%. Output 54 to 77 volts, 10 amp.

or Filament Transformers



Input 200/220/240 volts; Output 6.3 volts, 600 amps.

Acme ACME Electric

WILL DESIGN TO YOUR PERFORMANCE REQUIREMENTS

When performance and dependability are the most significantly important factors in your requirements, your best source of supply is Acme Electric. Send your prints and outline of application performance for confidential review and quotation.

ACME ELECTRIC CORPORATION
892 WATER STREET • CUBA, NEW YORK

Acme ACME Electric
TRANSFORMERS

Circle 100 on Inquiry Card, page 97

NOW! Immediate delivery on low-cost ultrasonic cleaning equipment you can afford!

Prices start at only $175.00— with a full two-year warranty

Series 600
$350

narda
SONBLASTER

Now, thanks to Narda's mass production techniques, you can get top ultrasonic cleaning equipment with a full two year guarantee, at the lowest prices in the industry! What's more, Narda's SonBlasters are available **now** — off-the-shelf — for immediate delivery! Here's your opportunity to start saving **immediately** on labor, chemicals and floor space — not to mention improved cleaning with fewer rejects.

Simply plug this new Narda SonBlaster into any 115 V-AC outlet — fill the tank with the cleaning solution of your choice and flip the switch. In seconds, you are cleaning everything from hot lab apparatus to medical instruments, optical and technical glassware to clocks and timing mechanisms, electronic components and semiconductors to motors, relays and bearings. In short, you will clean 'most any mechanical, electrical, electronic or horological part or assembly you can think of—and clean it faster, better and cheaper. In addition, Narda SonBlasters are ideal for brightening, polishing, decontaminating, sterilizing, pickling, and plating; emulsifying, mixing, impregnating, degassing, and other chemical process applications.

Write for more details **now**, and we'll include a free questionnaire to help determine the precise model you need.

Narda SonBlasters— a complete line of production-size units with the quality, power, performance, capacity and appearance of cleaners selling up to three times the price. From $175 to $1200.

Fill out and mail for full information—

SPECIFICATIONS

Inside tank dimensions: (Model NT-602) 9¼" l, 6" h, 5" w; one gallon capacity; stainless steel. **Generator:** 10" l, 8½" h, 9½" w; 115 V-AC; Selector switch for alternating between two tanks. **Complete unit is portable and compact.**

NARDA ULTRASONICS CORP.
Herricks Road, Mineola, L. I., N. Y.
Dept. EI-2

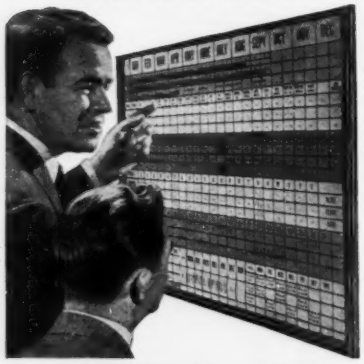
Please send me more information about Series 600 SonBlasters.

Name_____
Organization_____
Address_____
City_____ Zone____ State____

the narda ultrasonics corporation
HERRICKS ROAD, MINEOLA, L. I., N. Y.
Subsidiary of The Narda Microwave Corporation

Circle 101 on Inquiry Card, page 97

How To Get Things Done Better And Faster



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Write for Your Copy Today

GRAPHIC SYSTEMS

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Circle 80 on Inquiry Card, page 97

THE PUBLISHER ASKS

a favor from you who are users of our Annual June Directory issue. If you're one of the many who prefer the ELECTRONIC INDUSTRIES' directory issue to similar product-finding guides of other publishers, will you write and tell us why you prefer ours? Your letter will be shown to advertising men all over the United States. Your testimonial is as important to us as a sports or show business celebrity's would be to a consumer product. Can you spare a minute to write us a few lines?

ELECTRONIC INDUSTRIES

Chestnut & 56th Sts., Philadelphia 39, Pa.

New Products

LIGHTWEIGHT DIMMERS

New light-dimmer variable voltage power transformers produced are approximately a third lighter and smaller than customary, owing to aluminum cases and advanced design. Mounted with a calibrated dial that

eliminates guesswork, switch locks in at each voltage calibration. Tested and qualified to Mil Specs., the new Series is constructed of smokeless materials and will take a heavy overload. Available in ratings from 2 to 12 a., 28 v. at 400 cps. input, 0 to 28 v. out in ten calibrated steps. Osborne Electronic Corp., 712 S. E. Hawthorne Blvd., Portland, Ore.

Circle 235 on Inquiry Card, page 97

GAIN SET

A complete system for making precise measurements of gain or loss of near-zero up to 80 db in components or systems has been announced. Known as the Gain Set, this system consists of four basic components: a

pre-amplifier unit, an attenuator, an amplifier-detector, and a power supply. These components are placed on separate relay rack panels so that the user can assemble and connect them in whatever arrangement best suits his needs. All components are available either separately or as a complete system. Kay Electric Co., Dept. EI, Maple Ave., Pinebrook, N. J.

Circle 237 on Inquiry Card, page 97

PLUG-IN RESISTORS

New 2- and 3-unit side-by-side variable resistors equipped with plug-in mounting brackets have been announced. Available in twelve basic types, each with 17 shaft lengths, for TV receivers and other electronic assemblies. Printed wiring terminals and sturdy snap-in metal mounting brackets provide firm support for the multiple control assemblies. All con-

trols have screwdriver-slotted phenolic shafts adjustable from both sides. Available with terminals either parallel or perpendicular to shafts. Stackpole Carbon Co., St. Marys, Pa.

Circle 236 on Inquiry Card, page 97

VIDEO TRANSFORMERS

The availability of new wide band video transformers has been announced. These subminiature units of wide bandwith (50 cps to 8.0 mc) are used for creating economy and increasing equipment efficiency. They are supplied with solder terminals and meet all applicable Mil-Specs. ESC will design and develop wide band video transformers to meet par-

ticular applications. Each transformer prototype is accompanied by a comprehensive laboratory report. ESC Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 238 on Inquiry Card, page 97

Thermal Runaway

(*Continued from page* 80)

a value which is undoubtedly lower than the manufacturer's rating for collector voltage.

Unfortunately, bias stabilization methods by means of linear resistors will not do too much good with class B circuits, since the ac gain is reduced whenever the dc bias is stabilized. Unless bypass condensers are used (which is done with class A circuits) this decrease in power gain will be intolerable. Condensers of course can't in general be used for class B circuits because they will be too sluggish charging and discharging between signal and no-signal conditions.

Even in class A circuits, the factors which lead to good stability often reduce power gain, maximum power output, etc. When other design considerations besides stability are important, such as power gain, input and/or output impedances, allowable distortion, etc., a compromise must be made. For power stages often no suitable compromise can be found. This means the circuit designer will be forced to turn to other means of preventing runaway than those covered above.

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES • Chestnut & 56th Sts., Phila., Pa.

For class A circuits several "tricks" for insuring stability exist. One, early advocated by Shea,[4] involves the use of one transistor's collector current to bias another transistor—thus forcing the two transistors to have the same dc quiescent current. Another "trick" involves the use of negative feedback at dc around the final stage and one or two others preceding it. The feedback circuit is made to block the ac signal of interest.

Another is to mount the previous, direct-coupled stage near the output stage to get a thermal coupling effect. This will tend to stabilize the collector current of the second stage. This trick, unlike the other two, will work also for class B circuits.

Other class B tricks, outside the scope of this article, include use of varistors, diodes, or thermistors. In cases like this the preceding analysis does not hold, and the criteria for runaway prevention will be different, although the general principles of which quantities to keep small will be unchanged.

Whenever maximum power output under varying conditions of temperature and transistor interchangeability is desired, precautions have to be taken not only to maintain the bias point but to prevent thermal runaway.

References

1. W. W. Gartner, "Temperature Dependence of Junction Transistor Parameters." *Proc. I.R.E.* 45, 662 (May 1957).

2. C-T Sah, R. N. Noyce, and W. Shockley, "Carrier Generation and Recombination in P-N Junctions and P-N Junction Characteristics." *Proc. I.R.E.* 45, 1228 (Sept. 1957).

3. P. Penfield, Jr., "Transistor Bias Stabilization." *Audio*, May 1956 and July 1956.

4. R. F. Shea, "Principles of Transistor Circuits," Wiley, New York, 1953, Chapter 6, and R. F. Shea, "Transistor Audio Amplifiers," Wiley, New York, 1955, Chapters 3 and 6.

PANEL SPACE LIMITED? SPECIFY
DIALCO® 2-Terminal
Sub-Miniature Pilot Lights
COMPACT
RUGGED
OMNIDIRECTIONAL PLASTIC DOMES
COMPLETELY INSULATED
Also available with "Taper-Tab" quick-connect terminals
BACK of panel insertion
or FRONT of panel insertion
△ Dimming and ◁ Non-dimming types
Also
1-Terminal Pilot Lights
for use on grounded circuits. Available with *binding* screw or *soldering* terminal.
DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.
Complete details in Brochures L-156 A and L-157.
SAMPLES ON REQUEST—AT ONCE—NO CHARGE
Foremost Manufacturer of Pilot Lights
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Company .....
Address .....

Circle 81 on Inquiry Card, page 97

(*Continued from page* 132)

. . . it connotes selection of people from existing labor pools (viz., colleges and universities and normal transient pool). There are no longer labor pools of and kind. The demand is so great and the competition so keen that there isn't even a 5-minute period between sheepskin and slide rule. As for a transient pool, it is nonexistent except by compulsion. So, today we have to think in terms of "motivation," not "recruitment," of engineers.

Motivation better defines what needs to be done. The connotation here is to "move" engineers from whatever their present situation happens to be by means of a "selling process."

It is this selling process that has been almost totally neglected in Recruitment Advertising and paradoxically so in view of the fact that engineers are no different from anybody else. They Can Be Sold! And the same mental processes that move people to beer, bread, automobiles and new refrigerators can move engineers to new jobs.

Quite naturally help wanted classified advertising stems originally from the Employment and Personnel departments and are simply "Want Ads." This approach in a normal labor market probably would be sufficient; however, the situation today is anything but normal. The inability to project industry's engineering needs in these most dynamic fields of Electronics and Nucleonics has further complicated the job of personnel and employment people. The most crying need of personnel people is in filling immediate needs. Results cannot be too long in forthcoming.

You cannot, through the mechanical devices of big space ads, shouting headlines, pretty pictures, sandbag engineers into moving in your direction. You've got to motivate 'em, not recruit 'em. The difference between the two is the major premise. The key word is "benefit." The engineer must be made aware of a real benefit in his favor—if there is none, he will not budge.

The statement that "Engineers are people" is true . . . and leads us directly into the problem at hand . . . what appeals will influence an engineer to leave one position to go to another?

A very interesting piece of information is a survey, using engineers and engineering companies in the Avionics field and could be considered indicative of the all-over Engineer Procurement Problem. The survey embraced 18 major Avionics suppliers whose employees represent 25 to 40% of the Avionics industry total. Between 8% and 15% of the engineers questioned quit old jobs to take new ones. Higher salary and opportunity for greater responsibility are the two major reasons why they move. These outweigh all other factors combined. Geographical consideration is third.

A simultaneous survey was undertaken of 300 avionics engineers selected at random from the I.R.E. Directory. Jointly the companies surveyed employ 11,700 engineers, lost 1,400. They showed a gain of 2,300 engineers representing approximately a 24% net increase in the size of their engineering staffs.

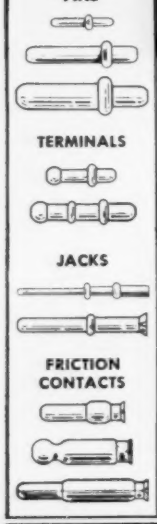
50% SAVINGS with BEAD CHAIN® Multi-Swage Parts

CONTACT PINS

TERMINALS

JACKS

FRICTION CONTACTS



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Contact pins, terminals, jacks or any small tubular parts. Maximum ¼" diameter x 1¼" length.

Send sketch for quotations.

BEAD CHAIN DRIVES

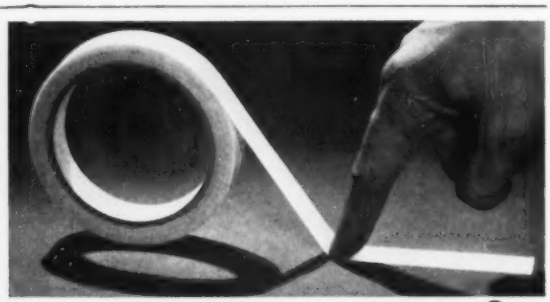
Low-speed positive drives or motion transfer ... at far less cost!

Send for Multi-Swage or Bead Chain Drive Catalogs!

THE BEAD CHAIN MFG. CO.

201 Mountain Grove St., Bridgeport 5, Conn.

Circle 82 on Inquiry Card, page 97



New TEMP-R-TAPE® C

.002" thick, 2750 v/m pressure sensitive TEFLON* tape For -100°F to 500°F applications

TEMP-R-TAPE® C, CHR's newest pressure-sensitive tape, is made of ultra-thin, high dielectric, cast Teflon film to which a silicone polymer adhesive has been applied. Both pressure-sensitive and thermal curing, the adhesive sticks well to any surface over a −100°F to 500°F (−70°C to 260°C) temperature range. Providing an easy-to-apply, extremely thin, high dielectric insulator (2750 volts/mil), TEMP-R-TAPE C was designed for and is now being used in the manufacture of miniature electronic units to withstand Class H and higher temperature requirements. *Send for data on TEMP-R-TAPE C and CHR's other extreme temperature, electrical and mechanical pressure-sensitive tapes.*

CONNECTICUT HARD RUBBER

NEW HAVEN 9 CHR CONNECTICUT

*du Pont TM.

Circle 83 on Inquiry Card, page 97

New Products

EPOXY RESINS

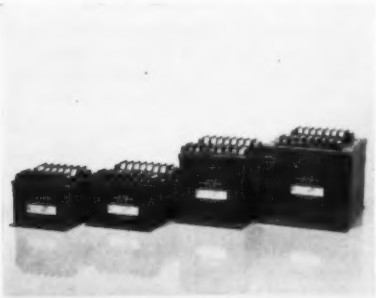
Three new high temperature epoxy resins have been added to the "Scotchcast" brand line of electrical insulating resins. They were developed to operate at elevated temperatures. The new family includes: No. 250—a two

part, rigid unfilled electrical insulating resin suitable for normal application of impregnation and embedment. No. 251—a filled version of No. 250, recommended for casting, impregnating and encapsulating applications where greater structural strength is desired. No. 252—has similar physical and electrical properties to the others, but formulated specifically for dipping applications. Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn.

Circle 233 on Inquiry Card, page 97

SWITCHING REACTORS

Standard line power Switching Reactors are offered in four nominal volt-ampere ratings of 15, 75, 150 and 300. These units translate inputs to plain logic, then perform switching operations for either ac or dc loads, depending on circuit arrangement. No special power supply is required for these reactors and they are com-



patible with other switching reactors. Units range in size from 3⅝ x 3 x 2¼ in. (15 va) to 5¼ x 5¼ x 4½ in. (300 va). Control, div. of Magnetics, Inc., Butler, Pa.

Circle 234 on Inquiry Card, page 97

BULOVA

FAMED FOR PRECISION SINCE 1875

NEW AM-100

"MULTI-PURPOSE" OVEN

Now Bulova pioneers an entirely *new*, ultra-simplified means of temperature compensation...the "multi-purpose" AM-100 oven.

The AM-100 is designed to yield exacting temperature control of more than just crystals. *Now* entire circuits, components and/or complete sub-assemblies can be housed in one, low cost unit...the highly stable AM-100.

By eliminating costlier, less dependable, heavier and more complex temperature compensating factors, hundreds of design hours can be saved...circuits can be simplified and more dependable, and have a far wider operating range.

THE AM-100 FEATURES: Rugged lightweight construction (less than 7⅛ oz.); Long life expectancy due to triple insulation on heater winding; High stability ± .1°C.; Standard octal plug-in (stud mounting available); The unit draws 20 watts on initial warm-up, with average dissipation of less than 5 watts after warm-up; Meets vibration tests per MIL-E-5272; Overall 3" diameter x 5" high – cylindrical cavity 1¾" diameter x 2¾" high.

A complete line of precision Bulova ovens are available in quantity, with custom designed units available on request.

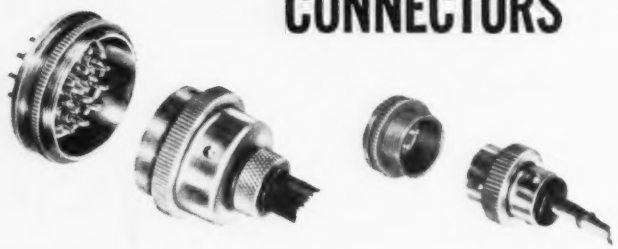
BULOVA watch company

Electronics Division
Woodside 77, N.Y.

Write Dept. A-765
Full Information
and Prices on Ovens

Circle 84 on Inquiry Card, page 97

A. R. C. CERAMIC INSULATED CONNECTORS



Minimize Leakage, Save Space

We developed this ceramic-insulated connector to obtain performance features we needed in our airborne communications and test equipment. Doubly silicone coated, it is virtually impervious to extremes of moisture, and mechanically stable under heat. Eight contact points per pin make for low contact resistance. Being of small overall dimensions, these connectors are space savers. 2, 3, 4, 6, 8, 12 and 19 contact connectors each are available in three-key keyway combinations to prevent incorrect insertion. Design them into your equipment for extra dependability. Write for details.

Dependable Airborne Electronic Equipment Since 1928

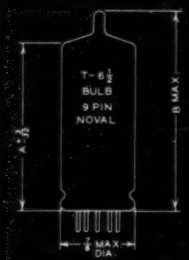
AIRCRAFT RADIO CORPORATION
BOONTON, NEW JERSEY

ARC

Circle 85 on Inquiry Card, page 97

A NEW CRYSTAL UNIT WITH EXCEPTIONAL STABILITY AND PRECISION IN RANGE 4 kc TO 3000 kc

RANGE	A	B
4-85 kc	2"	2 3/8"
85-150 kc	1 9/16"	1 15/16"
150-3000 kc	1 1/8"	1 1/2"



This all-glass vacuum mounted crystal unit provides maximum stability, with low effective series resistance, in the range between 4 kc and 3000 kc.

For example, in the range 800 kc to 3000 kc, stability of 4 parts in 100 million (4×10^{-8}) per day can be obtained when used with temperature control that holds ± 0.1°C. Under these conditions ageing will not exceed 2 parts in 100 million per day.

Supplied for oven or non-oven operation.

SPECIFY BLILEY BG7 SERIES.

Bliley

BLILEY ELECTRIC CO.
UNION STATION BUILDING • ERIE, PA.

Personals

Alfred Grebe is now Chief Engineer for Filtors, Inc. He was formerly head of research and development.

Alfred A. Crivello is now Project Engineer for the Avion Div. of ACF Industries, Inc., in the entire field of microwave components.

Everett R. Phillips has been appointed Field Engineering Supervisor in the Chicago District of the Electro-Data Div. of Burroughs Corp., Pasadena, Calif.

Zeke R. Smith is now Vice-President and Director of Engineering for Potter & Brumfield, Inc. He will be in charge of all products and applications engineering in their three plants located in Princeton and Franklin, Ky., and Lanconia, N. H.

Z. R. Smith

R. N. Brown

Robert N. Brown has been named Vice-President and Director of Engineering for the Kearfott Co. He joined them in 1946 and has held various engineering posts since.

Randolph F. Hill has been appointed Mechanical Engineer and **Mark Steidlitz**, Development Engineer of the Central Engineering Staff of the International Resistance Co.

Frank Clarke has been named Military Relations Engineer for the Texas Instruments Semiconductor-Components Div. with his headquarters in Washington, D. C.

Bernard L. Goldwasser has been made Supervisor of Process Engineering in the printed circuit department of Packard-Bell Electronics Corp.

Robert S. Kinsey is now Director of Engineering, Utica Div. of Bendix Aviation Corp.

George G. Hobert has been appointed to the newly created post of Manager, Special Data-Processing Equipment Engineering. He was formerly Associate Director of Engineering for Burroughs Corp.

Martin V. Kiebert, formerly Director of Electronics for the Miami Shipbuilding Corp., has joined Datalab, a division of Consolidated Electrodynamics Corp. as Proposals Coordinator.

Letters

to the Editor

(*Continued from Page 36*)

"Zeroing Synchros"

Editor, ELECTRONIC INDUSTRIES:

At the time that this information was first prepared, the authors were unaware of the existence of any industry-wide or military specifications for the zero definitions. For this reason we arbitrarily formalized on the definitions shown in the article as published. Subsequent to submission of this information and prior to its publication, we discovered that there had been several efforts made at standardization. Among these were the Society of Automotive Engineers Specification ARP-461 and various Defense Department pamphlets and technical manuals.

On the subject of synchros, these various publications are in agreement. The only corrections necessary to enter into agreement with these publications involves the synchro transmitter. These corrections are as follows:

Figure 3, interchange S1 and S3
Figure 4, interchange R1 and R2
Paragraph on "Zeroing Synchro Transmitters"

Towards the end of the paragraph, "at true null the scope pattern will go into negative phase for the condition mentioned."

On the subject of resolvers, considerable confusion exists. The aforementioned publications treat only the synchro resolver, a device used in the same manner as synchros, but with greater accuracy. The zeroing procedure described in the article is for a computing resolver and was based on a particular manufacturers component. Subsequent study of the mathematical computation involved has led us to completely redefine the computing resolver and, therefore, its zero and the method of obtaining the zero. . . .

Philip L. Hillman and
Francis J. Galvin
General Precision Lab.
Pleasantville, N. Y.

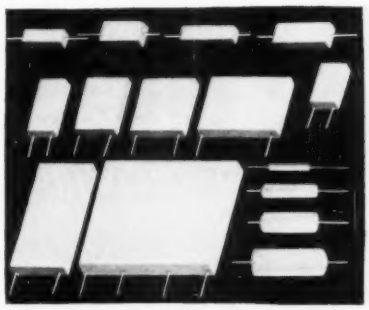
Engineering Students Show Small Increase

College students majoring in engineering in the United States and Territories increased by more than 20,000 last fall, according to the U. S. Office of Education. Enrollments totaled 297,077, compared with 277,052 a year ago.

The new figures show a climb of 131,440 in engineering enrollments since 1951. That year engineering attracted only 165,637 students.

NEW CTS BOBBINLESS PRECISION WIRE FIXED RESISTORS

Featuring Unique CTS "Floating" Element
Small Space Factor • More Stable

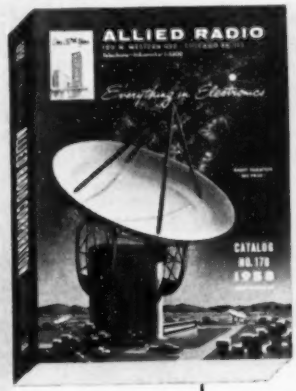


New CTS patented winding process now permits resistance elements and contacts to be firmly embedded in epoxy resin, forming a monolithic mass. No bobbin or winding form—no wire strain. Exceptional Stability—permanent change in resistance less than 0.2% under most environmental conditions.

Guaranteed Close Tolerance—resistors guaranteed to be in tolerance under normal conditions of measurement. Tolerances down to ± 0.05% available in standard sizes depending upon resistance value. Closer tolerances or matched multiples available.

Low Inductance and Low Capacitance Characteristics with reproducible uniform frequency response made possible by new CTS patented winding technique. Less than 0.2% resistance change with humidity (MIL-R-93). Less than 0.2% resistance change with temperature cycling (MIL-R-93). Withstands extreme vibration and shock due to unique construction and encapsulation method. Extremely stable—resistance change with load life or 100% overload (MIL-R-93) less than 0.3%. Low temperature coefficient wire available. Offered in rectangular or tubular shapes in a wide variety of standard sizes with wattages ranging from 0.25 to 2.0 and resistances from 0.1 ohms. Special dimensions, tolerances, wattage ratings, etc. can be made to your exact specification.

CHICAGO TELEPHONE SUPPLY CORPORATION
Elkhart, Indiana • Founded 1896
Circle 87 on Inquiry Card, page 97



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your best buying guide to the world's largest stocks of
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- Power & Gas Tubes
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- Test Instruments
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- AN Connectors
- Metal Chassis Bases
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Manufacturers' prices available on quantity purchases

our 37th year

Simplify and speed your purchasing of electronic supplies and equipment: send your orders to us for fast shipment from the world's largest stocks of electron tubes (all types and makes), transistors, test instruments (see our money-saving KNIGHT-KITS), audio equipment and electronic parts. Our expert Industrial supply service saves you time, money and effort. Send today for your FREE 1958 ALLIED Catalog—your *complete* Buying Guide to quality Electronic Supplies for Industrial and Communications use.

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Circle 88 on Inquiry Card, page 97

TEST
INSTRUMENTS
for
LABORATORY/PRODUCTION

Sensitive Detection of Microwave Energy

PRECISION TEST RECEIVER

The AIL Type 130 Precision Test Receiver (30 and 60 Mc standard units available) is a versatile instrument combining a high gain, low-noise figure receiver and a secondary standard of attenuation. It can be used wherever accurate measurements of the differences of r-f and i-f power levels are required. A few typical applications are: noise-figure measurement, measuring characteristics of directional couplers, calibration of r-f attenuators and measurement of selectivity characteristics.

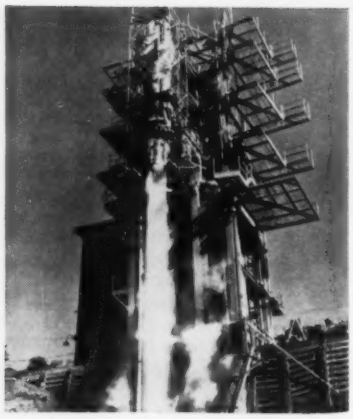
Detailed literature is available on request.

AIRBORNE INSTRUMENTS LABORATORY
INCORPORATED

1345 NEW YORK AVENUE
Huntington Station, L. I., N. Y.

Circle 89 on Inquiry Card, page 97

ROCKET TESTING



Fiery gases stream from a Redstone rocket engine as it delivers more than 75,000 lbs. of thrust during static test at Rocketdyne's Propulsion Field, Laboratory, Los Angeles.

Motorola Announces Battery TV Portable

"The first fully transistorized battery-operated portable tv set" was announced last month by Motorola. The target date for the first commercial models has been set early in 1960.

The first models will have a 14-in. picture tube and employ 31 transistors. One of the obstacles to mass production of the units is the availability of component transistors.

The set will be powered by two batteries which can be recharged from auto cigarette lighters or ac outlet. Operating cost will be in the neighborhood of 4/10 cent per hour.

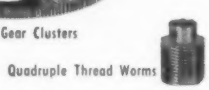
NEW FLYING SUIT

A life-size dummy checks the new integrated flying suit designed by the Martin Co. Parachute harness, life preserver, and signal flares are integral parts of the suit.

DESIGNED ENGINEERED PRODUCED

TO RIVAL NATURE'S PERFECTION...

That's the story of Boehme Fine Pitch Precision Gears. Hobbed to meet requirements that include up to ⅛" x 5" O.D. — 180 — 16 D.P. AGMA Precision #3.



. . . and when it comes to Boehme Precision Manufacturing Facilities

you'll find a whole new concept of design and engineering skills backed by experienced craftsmanship in the production of electrical, electro-mechanical and electronic products for automation and instrumentation.

Learn how Boehme can help you meet today's competitive demands. Send for descriptive literature, now — There is no obligation.

H. O. Boehme, Inc.
Designers and Manufacturers
Communication Equipment
Precision Electro-Mechanical
Apparatus Since 1917
915 Broadway New York 10, N.Y.

Circle 90 on Inquiry Card, page 97

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Increased Missile Work At Lockheed Aircraft

Missile sales represented 8 per cent of Lockheed's sales in 1957. In 1958 missile sales are expected to jump to 20 per cent of the gross sales, spearheaded by the accelerated program on the Navy's long range fleet ballistic missile, the Polaris.

Lockheed is forecasting a backlog during 1958 of close to the $1,300 million total at the end of 1957.

Total sales in 1958 are estimated at $750 million, down from the record $900 million rung up in 1957.

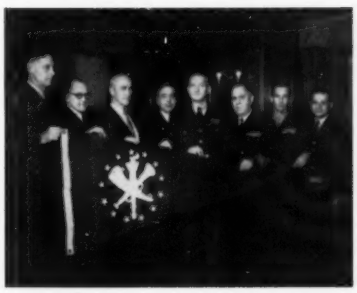
Chrysler Hiring Missile Personnel

Chrysler Corp. plans to add 4,000 to its Detroit-area payrolls during the next year for work on its missile program. The firm is presently hiring at a rate of 100 per day.

Approximately 25 per cent of those hired will be engineering personnel, 40 per cent qualified technical personnel and the remainder will fill both hourly-rated and salaried jobs ranging from highly skilled to unskilled.

In addition to the 4,000 new employees there will be a considerable rise in the payrolls of Chrysler sub-contractors working on Redstone and Jupiter projects. The firm deals with some 800 suppliers in Michigan and approximately 1,000 firms in 32 other states.

RESERVE AWARD



IT&T Corp. is cited by the Dept. of Defense for "outstanding cooperation with the Reserve Program of the Armed Forces." Holding pennant are Col. W. E. Jennings, Capt. R. C. Lawver, IT&T's Maj. Gen. E. H. Leavey (ret.), Lt. Col. D. Talley, Maj. Gen. R. E. Bell, RAdm. H. C. Perkins, Lt. Col. W. Nesbitt, Maj. S. Spadoni.

Peak Unemployment

New claims for unemployment compensation hit a 1957 record of 550,995 in the week ended Dec. 28, 1957. This was an increase of 137,400 from the week before.

The Labor Dept.'s Bureau of Labor Statistics said the increase was "substantially larger" than the usual year-end increase. The corresponding week of 1956 showed an increase of 50,000 to a total of 338,970.

"When my neighbor is out of work, it's a recession."

"When I'm out of work, it's a depression!"

Average Starting Salaries For College Men As Reported By 205 Companies

Field	Number Companies Reporting	$375 or less	$376 to $400	$401 to $425	$426 to $450	$451 to $475	$476 to $500	$501 and over	Average Starting Salary 1958	Average Starting Salary 1957
Engineering	162	0	2	8	34	70	44	4	$468	$454
Accounting	120	15	29	40	20	13	3	0	$416	$402
Sales	107	21	30	24	13	15	4	0	$412	$398
General Business Trainees	110	20	31	34	16	8	1	0	$408	$393
Other Fields	53	6	11	10	10	10	6	0	$429	$419
Average Starting Salary All Fields									$430	$411

—from "Trends in the Employment of College and University Graduates in Business and Industry," Northwestern Univ.

NBS' Summer Program Recruits Scientists

A program which gives students an opportunity to become acquainted with a Government research laboratory during their summer vacation periods is helping the National Bureau of Standards to meet its increasing demand for high-caliber technical graduates. Having discovered the advantages of a career at the Bureau, 174 of 1957's record enrollment are maintaining NBS affiliation: of the 236 students employed at the Washington laboratories in the past summer, 44 are still on full- or part-time duty and 130 who plan to return to the Bureau have been granted leave without pay to continue their education. One-half of the 208 students employed in 1956 were included in last summer's program. Another 57 had remained on duty permanently. The program, inaugurated in 1948, was extended to the NBS laboratories in Boulder, Colorado, in 1956, where it has already resulted in a number of permanent appointments.

Nearly Half of PhD's Attend Public Schools

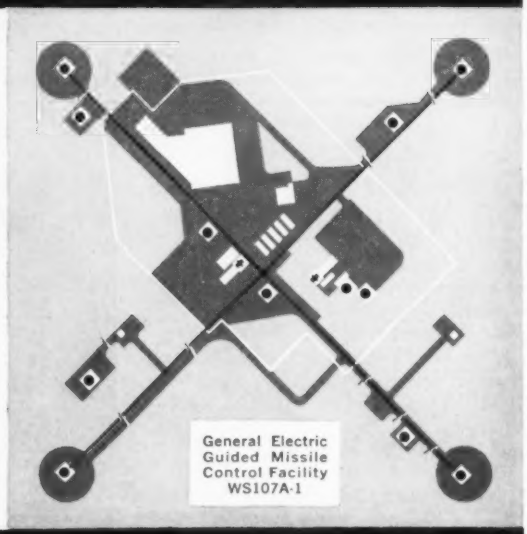
More than 47% of all who received doctoral degrees in science from 1936-50 had their "undergraduate origins" in public U. S. institutions, reports the American Assoc. of Land-Grant Colleges and State Universities. Land-grants and state schools accounted for 38% of this total. The Association also reported that a survey of all General Electric employees who have degrees from 4-year accredited schools shows that land-grant and state institutions supplied 47% —with Purdue Univ. (723) and M.I.T. (625) far in the lead.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 99.

GRADUATE EE'S: GENERAL ELECTRIC DISCLOSES HIGH PRIORITY PROGRAM FOR ATLAS GUIDANCE SYSTEM. MANY POSITIONS OPEN IN ELECTRONIC MISSILE TECHNIQUES=

ACCURACIES ON ORDER OF 1 PART IN 10 MILLION

required for portions of G.E.'s ICBM ATLAS Guidance System



Delivering an ICBM over a > 5000 mile trajectory into the target area demands a guidance system of unprecedented accuracy — and this is the calibre of the electronic system General Electric engineers are creating for ATLAS.

But achieving designated accuracies and reliabilities in the laboratory is not enough. *These high standards must be maintained in actual operational environments, with virtually no interruption or degradation.*

CAREERS IN STEP WITH THE FUTURE

Engineers who join the Missile Guidance Product Section of G.E. are doing more than hastening development of one of the nation's most urgent programs — guidance for ATLAS. As Manager of the Section Richard L. Shetler states: *"With this job behind us, there will remain no significant obstacle to the practical guidance and navigation of other space vehicles."*

PROGRAM ACCELERATION OPENS UP POSITIONS AT ALL LEVELS IN:

- Systems analysis, evaluation & integration
- Systems and component reliability
- Transistorized circuits, pulse circuitry, IF-Video circuits
- RF and Microwave components & plumbing
- Communications control devices
- Doppler radar design & development
- Digital data processing techniques, data transmission involving D & D of ground-based & airborne antennae, transmitters, receivers; application of transducers, transponders, etc.
- Test operations, including planning, range instrumentation & test execution; development & application of automatic test equipment

If you feel that your special skills and interests fit you to work in any of the above areas, why not write us in detail? Qualified candidates will be invited to visit our facilities to meet with technical managers and gain first hand knowledge of the living advantages of our locations at Syracuse and Utica, N. Y.

Write in complete confidence to Mr. E. A. Smith, Room 2-D
MISSILE GUIDANCE PRODUCT SECTION

GENERAL ELECTRIC

Court Street, Syracuse, N.Y.

A Look At . . .

The International Electrotechnical Commission

This 50-year old organization coordinates and unifies national electrotechnical standards by drawing up recommendations upon which the National Standards of member countries can be based.

THE International Electrotechnical Commission is generally known by its initials "I.E.C." In French it is called "Commission Electrotechnique Internationale", abbreviated "C.E.I."

The object of the Commission is to facilitate the co-ordination and unification of national electrotechnical standards and to co-ordinate the activities of other international organizations in this field.

Any self-governing country desiring to participate in the work of the Commission may form a committee for its own country and apply for membership of the Commission. The committee when it has been accepted as a member is known as the "National Committee."

The National Committees of the I.E.C. are composed of representatives of the various technical and scientific organizations which deal with questions of electrical standardization on the national level. Most of them are recognized and supported by their respective governments.

There is only one Committee for each country.

The following thirty countries are members:—

Argentina	Italy
Australia	Japan
Austria	Netherlands
Belgium	Norway
Brazil	Poland
Canada	Portugal
Czechoslovakia	Spain
Denmark	Sweden
Egypt	Switzerland
Finland	Thailand
France	Union of South Africa
German Federal Republic	United Kingdom
Hungary	United States of America
India	U.S.S.R.
Israel	Yugoslavia

To attain its object the I.E.C. publishes recommendations which, as far as possible, express international agreement upon the subjects dealt with. Although I.E.C. Recommendations are not binding upon the member organizations, these latter are strongly recommended to follow them when drawing up their national specifications, so as to unify all national specifications and to facilitate commerce.

Organization

The work of the I.E.C. is carried on by a Council, a Committee of Action, a Central Office and Technical Committees.

Most of us in the Electronic Industries are thoroughly familiar with the roles of such engineering societies as the Institute of Radio Engineers, American Institute of Electrical Engineers, Electronic Industries Association, etc. We are also familiar with the values of individual participation on committees in these societies. Today, with the attention now focused on foreign engineering developments, we believe that information on an international organization that has been engaged in the development of electrotechnical standards for over fifty years will be of great interest.

The administration of the I.E.C. is carried out by a *Council* composed of:—

1. the President of the I.E.C.;
2. Presidents of National Committees who are *ex officio* Vice-Presidents;
3. the Treasurer;
4. the Secretary.

The Council meets at least once every three years.

Committee of Action: The Committee of Action is elected by the Council. It is composed of the President of the Commission and 9 Vice-Presidents or their duly accredited deputies. The past-President, the Treasurer and the Secretary are members *ex officio*, but without vote. Members are elected for a period of 9 years, a third being elected at the end of each 3-year period.

The Committee of Action has authority to deal with all administrative questions in the interval between the meetings of the Council. It takes all decisions which it considers necessary to facilitate the operation of the technical work of the Commission. It reports all its decisions to the Council.

(*Continued on page* 147)

Here G. D. Schott (right), Flight Controls Department head, discusses computer solutions of control and guidance problems with E. V. Stearns (center), Inertial Guidance Department head, and J. E. Sherman, Analog Computer Section head.

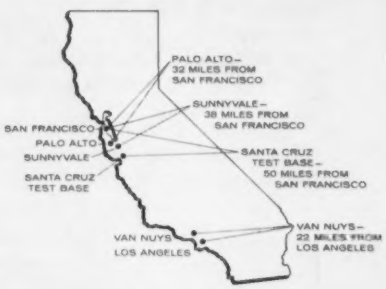
Lockheed Missile Systems announces new positions in

MISSILE FLIGHT CONTROLS – *the creative field for engineers*

Few fields equal missile systems flight controls in the need for original thinking. The ever-increasing performance of missiles presents problems that grow constantly in complexity. At Lockheed, weapon systems programs demand important advances in flight controls. Emphasis is on new ideas, new techniques.

Positions are open on the Sunnyvale and Palo Alto staffs for engineers possessing strong ability and interest in: Research and development of advanced flight control systems for controlling missiles and rockets; system synthesis by application of control system feedback techniques; analysis and design of nonlinear servo systems; development of transistor and magnetic amplifier techniques in the design of advanced flight control systems; analysis and simulation of the dynamic performance of the guidance – autopilot – airframe combination; development of systems utilizing advanced types of inertial and gyroscopic instruments; analysis and design of hydraulic servo systems for controlling missiles at high Mach numbers; environmental and functional testing of prototype flight control systems.

Inquiries are invited from engineers possessing a high order of ability. Address the Research and Development Staff, Sunnyvale 5, California.



Lockheed **MISSILE SYSTEMS** . A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS • CALIFORNIA

Electrotechnical Commission

(*Continued from page* 145)

Central Office: The Central Office is the permanent office which sees to the execution of the decisions of the Council and which carries on the work of Secretariat of the I.E.C.: reproduction and circulation of documents, organization of meetings, accountancy, etc. Its address is the registered office of the I.E.C.

Technical Committees: The technical work of the Commission is carried out by Technical Committees, each dealing with a given subject. These are set up by the Council, or by the Committee of Action, on the proposal of one or more National Committees and after all the National Committees have been consulted by the Central Office. The scope of the Technical Committee is fixed at the time of its formation and must be approved by the Committee of Action.

Any National Committee may be represented on any Technical Committee.

A Technical Committee has a chairman and a Secretariat appointed by the Committee of Action. One of the National Committees is appointed as Secretariat and assumes responsibility for the progress of the work.

Technical Committees meet whenever their Chairman and Secretariat consider a meeting to be necessary, either during the general meetings of the I.E.C. or at some other date.

The texts which have been approved by the appropriate Technical Committees and ratified by at least four-fifths of the National Committees are published as Recommendations. A list of recommendations which have been published up-to-date by the I.E.C. is given in Table 1.

Activities

The work of the I.E.C. covers almost all spheres of electrotechnology, including both power and light current fields. It can be divided into two categories:—

1. Work aiming at improving understanding between electrical engineers of all countries by drawing up common means of expression: unification of nomenclature; agreement on quantities and units, their symbols and abbreviations; standardization of systems of units; graphical symbols for diagrams.
2. Standardization of electrical equipment proper, involving the study of problems of the electrical properties of materials used in electrical equipment, standardization of guarantees to be given for certain equipment as to the characteristics, methods of test, quality, safety, and dimensions controlling interchangeability of machines and electrical equipment.

   The I.E.C. holds at least once each year a general meeting including meetings of a number of Technical Committees and a meeting of the Committee of Action.

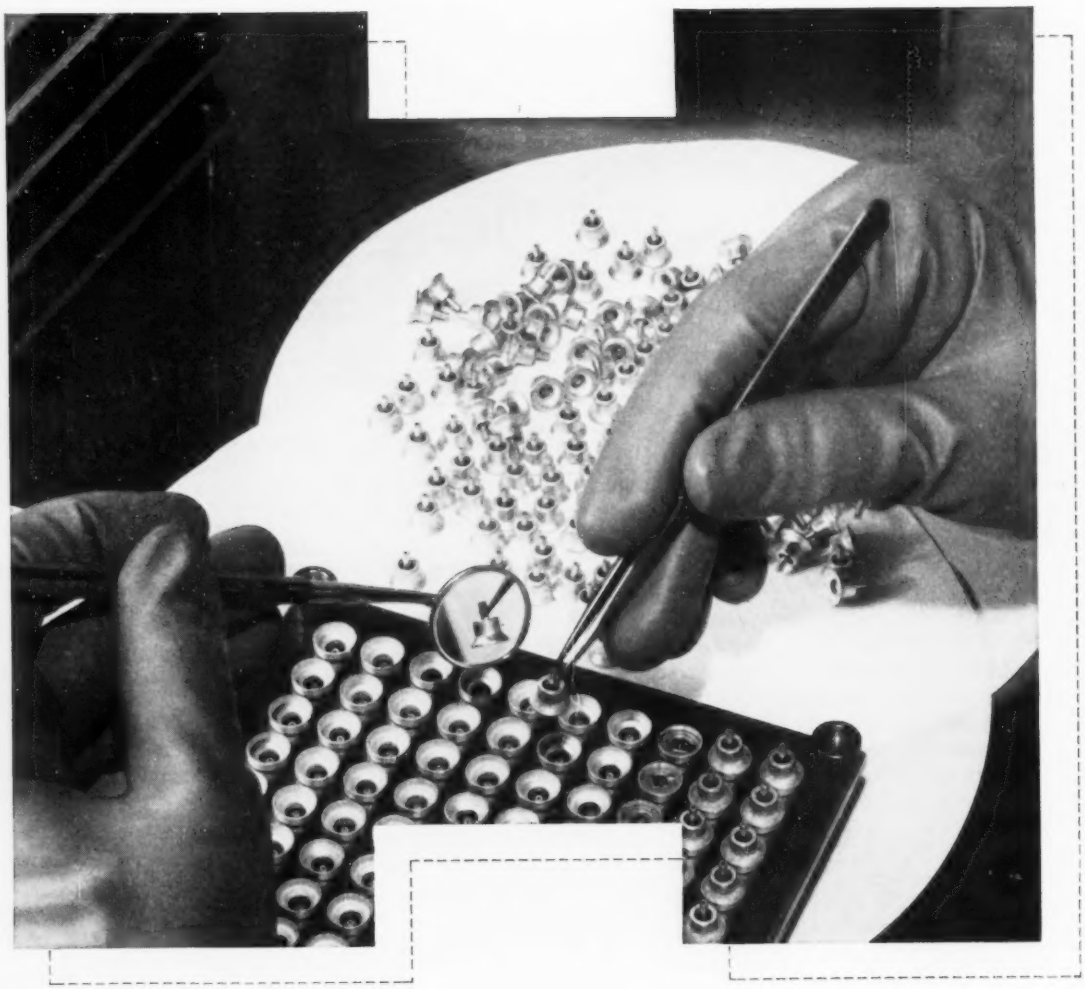
The work of the Commission is financed by contributions from the National Committees.

The amount of these contributions is fixed by the Council. (*Continued on page* 152)

NATIONAL COMMITTEES OF THE I.E.C.

Argentina—Comite Electrotecnico Argentino, Posadas 1659, Buenos Aires
Australia—Australian Electrotechnical Committee, Standards Association of Australia Science House, Gloucester & Essex Streets, Sydney
Austria—Osterreichisches Elektrotechnisches Komitee, Elektrotechnischer Verein Osterreichs, Eschenbachgasse 9, Wien I
Belgium—Comite Electrotechnique Belge, Rue Ducale 63, Bruxelles
Brazil—Comite Brasileiro De Electrotecnia e Illuminacao, Associacao Brasileira de Normas Technicas, Avenida Almirante Barroso, N°54-15° andar, Caixa Postal N° 1680, Rio de Janeiro
Canada—Canadian National Committee of the I.E.C., Canadian Standards Association, National Research Building, Ottawa (Ont.)
Czechoslovakia—Urad Pro Normalisaci, Vaclavske nam. 19, Praha II
Denmark—Dansk Elektroteknisk Komite, Vesterbrogade 1, Kobenhavn V
Egypt—The Egyptian National Committee of the I.E.C. operates under the Electrical and Mechanical Department of the Ministry of Public Works, Cairo
Finland—Suomen Standardisoimisliitto, r.y., Kasarmik 44A, Helsinki
France—Comite Electrotechnique Francais, Avenue Marceau 54, Paris (8°)
German Federal Republic—Deutsches Komitee Der I.E.C. beim VDE, Osthafenplatz 6, Frankfurt (Main)
Hungary—Magyar Szabvanyugyi Hivatal, Ulloi-ut 25, Budapest IX
India—Indian Standards Institution, University Road 19, Civil Lines, Delhi 8
Israel—The Standards Institution of Israel, Dizengoff Road 200, Tel-Aviv
Italy—Comitato Electrotecnico Italiano, Via San Paolo 10, Milano
Japan—Japanese Industrial Standards Committee, c/o Standards Division, Agency of Industrial Science and Technology, Ministry of International Trade and Industry, Ginza-Higashi 7-5, Chuo-ku, Tokyo
Netherlands—Nederlandsch Electrotechnisch Comite, Centraal Normalisatiebureau, Groenhovenstraat 13, 's-Gravenhage
Norway—Norsk Elektroteknisk Komite, Postboks 2208 Mj. Oslo
Poland—Polski Komitet Normalizacyjny, ul. Swietokryska 20-22, Warszawa 51
Portugal—Comissao Electrotecnica Portuguesa, Rua de S. Sebastiao da Pedreira 37, Lisboa
Spain—Comision Permanente Espanola de Electricidad, Plaza de la Lealtad 4, Madrid
Sweden—Svenska Elektriska Kommissionen, Malmtorgsgatan 10, Stockholm 16
Switzerland—Comite Electrotechnique Suisse, c/o Association Suisse des Electriciens, Seefeldstrasse 301, Zurich
Union of South Africa—Council of the South African Bureau of Standards, Private Bag 191, Pretoria
Thailand—National Energy Authority, Engineering Building No. 1, Chulalongkorn University, Bangkok
United Kingdom—British National Committee of the I.E.C., British Standards Institution, British Standards House 2, Park Street, London, W. I.
U.S.A.—United States National Committee of the I.E.C., American Standards Association, East Forty-fifth Street 70, New York 17, N. Y.
U.S.S.R.—U.S.S.R. National Committee of the I.E.C., Committee for U.S.S.R. participation in International Power Conferences, Ministry of Power Stations, Kitaiski Proiezd 7, Moscow, 74
Yugoslavia—Jugoslovenski Elektrotehnicki Komitet, Savezna Komisija za Standardizaciju, Admirala Geprata 16, Post. fah 933, Beograd

"INCUBATOR BABIES"



WITH A LONGER LIFE-SPAN

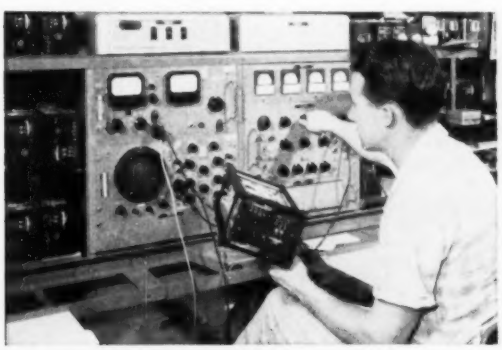
Reliability . . . one of the electronics industry's most pressing problems. Today, a system must not only work efficiently—it must often perform operations under highly adverse conditions.

Hughes Products, the commercial activity of Hughes, markets a wide variety of reliable systems and components to industry . . . ranging from semiconductor devices, electron tubes, instruments and electro-mechanical components, to control systems. In order to establish tight quality control, all functions—research and development through manufacturing—are performed by Hughes Products personnel.

One important phase in producing reliable products is careful control at each step in the manufacturing process. The assembly of the tiny Hughes transistors shown at left, for example, is carried out under glass in a dust-free, moisture-free atmosphere. The care given these "incubator babies" assures the quality needed for reliable performance.

Reliability is given high priority in *every phase* of the Hughes operation. Years of study and experiment—in research, development, and manufacturing—have given Hughes electronic armament systems, radar warning systems, guided missiles, and commercial electronics products a reputation for high standards of performance under all kinds of conditions.

The constant advance of Hughes into newer and more challenging fields benefits the present and prospective employee by assuring him an opportunity to progress with a leader in his field.



Precise evaluation of highly complex electronics armament systems requires that manufacturing engineers design and develop test equipment frequently as complex as the system being tested.

Setting the stage for new product developments, the Hughes Research & Development Laboratories delve into basic theory. Here R&D engineers work with a slot-array microwave antenna.

Highly rewarding positions are now open for experienced engineers, including the areas of:

Circuit Design	Systems Analysis
Reliability	Semiconductor Applications
Microwaves	Semiconductor Sales
Computers	Solid State Physics

Write, briefly outlining your experience to Mr. Phil Scheid, Hughes Personnel, Bldg. 17D, Culver City, California.

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HUGHES

HUGHES AIRCRAFT COMPANY
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Tucson, Arizona

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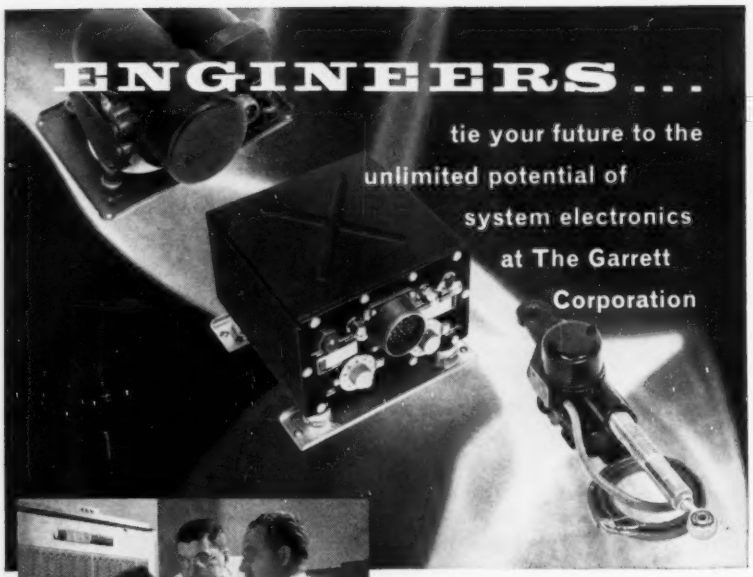
Circle 502 on Opportunities Inquiry Card, page 93



As communication and control problems multiply, one of the most rapidly growing of all missile and aircraft fields is that of system electronics. Stick-force reversal problems are solved by the air data system above.

- **TECHNICAL DEVELOPMENT ENGINEERS—ELECTRONICS** Graduate engineers required for preliminary design and analysis of electronic-mechanical systems involving closed-loop servos and low frequency amplifier circuitry. A mathematical background and experience with problem setups on digital and analogue computers are essential.
- **TECHNICAL DEVELOPMENT ENGINEERS—FLIGHT INSTRUMENTS & TRANSDUCERS** Graduate engineers required for preliminary design and analysis of small, precision, electro-mechanical, pneumatic devices involving bellows, diaphragms, cams, proportional pickoff sensors, pneumatic amplifiers, servo loops, etc. A mathematical background and experience with problem setups on digital and analogue computers are very desirable.
- **OPERATIONAL ENGINEERS** Graduate engineers for follow-on development of the above mentioned product categories. This work includes such activities as: laboratory circuit development of breadboards and prototype hardware, specialized test equipment design and construction, liaison with design drafting group, liaison with customer during initial equipment installation in aircraft, engineering instruction writing for inspection and production departments, and additional engineering functions necessary for establishing efficient production of the equipment hardware.
- **COMPONENTS ENGINEERS** Graduate engineers to act as consultants in matters of vendor contact on electronic and electro-mechanical components. These positions require experience in component testing as on potentiometers, capacitors, etc., and a knowledge of relative qualities and state-of-the-art of such components as manufactured by various vendors. Familiarity with military aircraft specifications desirable.
- **DRAFTING DESIGN ENGINEERS** Designers required for board work in originating packaging designs of electronic, electro-mechanical, and precision miniature pneumatic mechanisms.

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News of Reps

Reps Wanted

A manufacturer of **metallized Mylar film capacitors and radio noise filters** desires sales engineers in several key areas. (R 2-1, Editor, Electronics Industries.)

A manufacturer of **magnetic cores** for magnetic amplifiers, converter and computer applications desires reps in a number of territories such as Texas, Chicago, Detroit, Cleveland and Pittsburgh. (R2-2, Editor, Electronic Industries.)

E. E. Whittaker, P. O. Box 3255, Arnprior, Ontario, Canada, has been appointed rep for Spectrol Potentiometers in Canada.

The Components Div. of Epsco, Inc., Boston, announces the appointment of 3 new field representatives: **Richard F. Kimball Co.** of Dallas, covering Oklahoma and Texas; **Smith & Purdy Assoc.** of Walpole, Mass., covering New England; and **W. Ben Wimberly Co.,** of Clearwater, covering Florida.

K. C. Burcaw & Co. has been named rep in Michigan, and **Paul Nief Associates** has been appointed to represent the High Fidelity Div. of The Gray Mfg. Co. in the New England area.

Lawrence C. Freeman has established a new rep firm. Their offices are located at 24 Stephen St., Montclair, N. J.

Conrad R. Strassner Co. has been appointed sales rep for Automation Electronics, Inc. The rep firm covers Arizona, California, New Mexico, and Nevada.

Engineering Services Co. are now sales and service rep in the states of Kansas, Missouri, Nebraska and Western Iowa for the Narda Microwave Corp.

The A. H. Bruning Co. of Chicago, Ill., has been named rep for the Alpha Wire Corp. in Illinois and Eastern Wisconsin.

John J. Kopple Associates of 9 Prospect St., Mt. Vernon, N. Y., are now handling the sales of VecTrol thyratron phase controls and associated devices in New York, New Jersey and Eastern Pennsylvania.

Robert R. Stone & Associates, P. O. Box 3534, 1925 Lee Rd., Cleveland Heights 18, Ohio, are now representing Gibson Electric Co. in Western Pennsylvania, Eastern Ohio, and West Virginia.

The Gillette Engineering Co. of Phoenix, Ariz., has just been appointed sales reps in the states of Arizona and New Mexico for Westport Electric.

News of Reps

The selection of the **Polytechnic Institute of Brooklyn** to receive the second annual Electronic Engineering Reps scholarship award for the year 1957-58 was announced. The Electronic engineering reps making the award are **Burlingame Assoc., Ltd., G. Curtis Engel and Assoc., Inc., Gawler-Knoop Co. and RMC Assoc.** They present the scholarship every Christmas to a deserving fourth year student of electronic engineering.

Hamner Electronics Co., Inc., of Princeton, N. J., has appointed **Crossley Assoc., Inc.,** their reps. The territory includes Illinois, Indiana, Iowa, Minnesota, Nebraska, North Dakota, South Dakota, Southwest Ohio and Wisconsin.

Eltron Engineering Sales, Inc., 246 Walnut St., Newtonville, Mass., has been appointed sales rep for Hyperion, Inc., Electro-Physics Laboratories, and Industrial Electronic Engineers.

Cerruti & Hunter Associates, 841 Woodside, Redwood City, Calif., have been named reps for Thermo Materials, Inc.

Jerrold Electronics Corp. has named three new reps for their electronic test equipment division. They are **Gerard G. Leeds Co., Inc.,** Great Neck, N. Y., for New England, New York, Eastern Pennsylvania, Virginia and Washington, D. C.; **ARVA,** an affiliate of the Ron Merritt Co., Seattle, Wash., for Washington, Oregon, Montana and Idaho; and **Instruments for Measurements,** Hollywood, Calif., for Southern California and Southern Nevada.

Osborne Electronics Corp., Hawthorne, Calif., are now sales reps for Hill Transformer Co., Inc.

Bakelite Co., Div. of Union Carbide Corp., has announced the appointment of **Cadillac Plastic & Chemical Co.,** 15111 Second, Detroit 3, as national distributor of Bakelite epoxy resins and hardeners.

The Hodges Co., 2126 Irving Blvd., Dallas 7, Tex., will handle Texas and **Tanler & Co.,** 10633 Twilight Drive, St. Louis, Mo., will cover Missouri for the George Stevens Mfg. Co., Inc.

John E. Boeing Co., Arlington, Mass., are now New England sales reps for the Bradley Labs., Inc., line of metallic rectifiers.

Scientific Sales Engineering Co. has just been formed with headquarters at 2162 Piedmont Dr., N. E., Atlanta, Ga. They are specializing in laboratory and industrial electronic instrumentation. Their organization will cover the states of North Carolina, South Carolina, Georgia, Florida, Alabama and Mississippi.

ENGINEERS *Electronic & Mechanical*
Physicists:

Sometimes it pays to break tradition

Tradition is being broken every day at Melpar as we promote engineers to positions of responsibility regardless of their ages or the duration of their service. In a young, dynamically growing electronic R & D organization such as ours only one factor carries real weight. That factor is individual ability.

The fact that the average age of our 1000-man professional staff is one of the youngest in the country is tangible evidence of our advancement policy's emphasis on skill and performance.

There's never a lack of higher level positions to which the engineer of ability may advance, because we've doubled in size every 18 months for the past 11 years and our growth continues at a rapid pace. We promote from within whenever and wherever possible. By means of our project team basis of organization, work of merit is readily recognized and rewarded without delay.

Our wide diversification—we are presently engaged in more than 100 different projects—gives you the opportunity to tackle challenging problems in a variety of fields.

Our main laboratory is situated on a 44-acre wooded tract in a desirable suburb of Washington, D. C. Lovely homes and apartments are available near the laboratory. Nearby Washington offers a wealth of cultural and recreational attractions, and splendid educational facilities.

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A Subsidiary of Westinghouse Air Brake Co.
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10 miles from Washington, D. C.

Electrotechnical Commission

(*Continued from page* 147)

The languages of the Commission are English, French and Russian. The I.E.C. recommendations are published in these three languages.

History

During international electrical congresses held at the end of the last century, it was agreed that a permanent organization capable of carrying out electrotechnical standardization in a methodical and continous manner was necessary. Colonel R. E. CROMPTON (United Kingdom) was entrusted by the St. Louis Congress, in 1904, with the organization of such a body.

During the first meeting held at London in 1906, the constitution of the International Electrotechnical Commission was discussed and provisional statutes were drawn up.

Fourteen National Committees having been officially formed, the Council of the I.E.C. met for the first time in London in 1908 and approved the first statutes of the Commission which remained almost unchanged until 1949.

Since its foundation, the Commission has held many meetings which have led to the publication of important Recommendations.

In 1947 the International Electrotechnical Commission became affiliated with the International Organization for Standardization (ISO) as its electrical division, whilst preserving its technical and financial autonomy. In this capacity, the Commission has at present consultative status (Category B) with the Economic and Social Council of the United Nations.

Table 1: Recommendations Published by the I.E.C.

No.	
27.	International Letter Symbols used in connection with Electricity—Quantity Symbols—Alphabets and Letter type. (3rd Edition, 1953)
28.	International Standards of Resistance for Copper (1925)
34-1.	I.E.C. Recommendations for Rotating Electrical Machinery (excluding Machines for Traction Vehicles) (5th Edition, 1953, Part I)
34-2.	I.E.C. Recommendations on Determination of Efficiency of Rotating Electrical Machinery (excluding Efficiency of Traction Motors) (5th Edition, 1955, Part II)
38.	I.E.C. Standard System Voltages (3rd Edition, 1954)
*43.	I.E.C. Recommendations for Alternating-Current Watt-Hour Meters (1931)
*44.	I.E.C. Recommendations for Instrument Transformers (1931)
48.	I.E.C. Rules for Electric Traction Motors (3rd Edition, 1955)
50 (05)	International Electrotechnical Vocabulary (2nd Edition)—Group 05: Fundamental Definitions
50 (07)	International Electrotechnical Vocabulary (2nd Edition)—Group 07: Electronics
50 (10)	International Electrotechnical Vocabulary (2nd Edition)—Group 10: Machines and Transformers
50 (11)	International Electrotechnical Vocabulary (2nd Edition)—Group 11: Static Converters
50 (12)	International Electrotechnical Vocabulary (2nd Edition)—Group 12: Transductors
*52	Rules for the Measurement of Test-Voltage at Power-frequencies in dielectric Tests by Sphere Gaps (1935)
56-1.	I.E.C. Specification for Alternating-current Circuit-Breakers. Chapter I: Rules for short-circuit conditions (2nd Edition, 1954)
56-2.	I.E.C. Specification for Alternating-current Circuit-Breakers. Chapter II: Rules for normal load conditions (2nd Edition, 1955)
59	I.E.C. Standard Current Ratings (1938)
*60.	General Specifications for Impulse-Voltage Tests (1938)
61.	International Recommendations regarding Lamp Caps and Holders together with Gauges for the control of Interchangeability (1952)
	First supplement to Publication 61
62.	Colour Code for Fixed Resistors (1952)
63.	Series of preferred values and their associated tolerances for Resistors and Capacitors (1952)
64	International Specification for Tungsten Filament Lamps for General Service (2nd Edition, 1954)
65	Safety requirements for electric mains-operated Radio Receiving Apparatus (1952)
65-I.	Safety requirements for electric mains-operated Amplifiers (1955)
65-II.	Safety requirements for independent Loudspeakers (1955)
66	I.E.C. Specification for Fuses for voltages not exceeding 1 000 V for A.C. and D.C. (1st Edition, 1953)
67.	Dimensions of Electronic Tubes and Valves (1st Edition, 1954)
	First Supplement to Publication No. 67 (1955)
68.	Basic climatic and mechanical robustness testing procedure for components for radio-communication (1st Edition, 1954)
69.	Recommended methods of measurement of receivers for amplitude modulation broadcast transmission (1st Edition, 1954)
70-1.	Specification for Capacitors for power systems (Part I)—(1st Edition, 1954)
70-2.	Specification for Capacitors for power systems (Part II)—(1st Edition, 1955)
71.	Recommendations for Insulation Co-ordination (1st Edition, 1954)
72.	Report on I.E.C. work on Standard Dimensions of Electric Motors (1954)
73.	I.E.C. Recommendations regarding the colour of Push-buttons (1st Edition, 1955)
74.	Report of the work of the Permanent Sub-Committee of Technical Committee No. 10: Insulating Oils (1st Edition, 1955)
75	I.E.C. Specification for porcelain Insulators for overhead lines with a nominal voltage of 1 000 Volts and upwards (1st Edition, 1955)
76.	I.E.C. Recommendations for Power Transformers (1st Edition, 1955)
77.	Specification for Electrical Control Equipment installed on Motor Vehicles (1st Edition, 1955)

* New edition in preparation.

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A Chilton Publication

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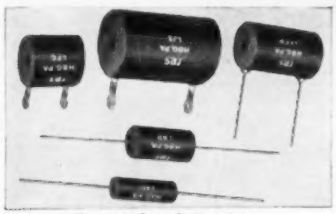
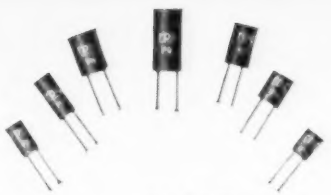
Circle 75 on Inquiry Card, page 97

rpc RESISTORS
PRECISION WIRE WOUND • HIGH VOLTAGE • HIGH MEGOHM • HIGH FREQUENCY



Encapsulated Precision Wire Wound Resistors

RPC Type L Encapsulated Resistors will withstand temperature and humidity cycling, salt water immersion and extremes of altitude, humidity, corrosion and shock without electrical or mechanical deterioration. Type L resistors are available in many sizes and styles ranging from sub-miniature to standard with lug terminals, axial or radial wire leads. Available for operation at 105° C. or 125° C. ambient temperatures. These resistors will meet all applicable requirements of MIL-R-93A, Amdt. 3. Type L can be furnished with all resistance alloys and resistance tolerances from 1% to .02%.



Printed Circuit Precision Resistors

To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors. Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93A, Amdt. 3. Available in 6 sizes, rated from 1/10 watt to .4 watt. ¼" diameter by 5/16" long to 3/8" diameter by ¾" long. Resistance values to 3 megohms. Tolerances from 1% to 0.05%.

High Frequency Resistors

Used where requirements call for very low inductance and skin effect in circuits involving pulses and steep wave fronts. Depending on size and resistance value, these resistors are usable at frequencies to over 400 mc. Resistance values range from 20 ohms to 100 megohms with tolerance of 20% to 5%. 2 types available.
TYPE F resistors (shown) in 8 sizes from 9/16" long x 0.10" diameter to 6½" long x 9/16" diameter, with lugs or wire leads. Power ratings ¼ to 10 watts.
TYPE G resistors (not shown), in 6 sizes up to 18½" long. Power ratings 10 to 100 watts.

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SPECIALIZING IN THE MANUFACTURE OF QUALITY RESISTORS IN ANY AMOUNT

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BAND PASS FILTERS					DISCRIMINATORS				
Catalog No. $Z_o = 500\,\Omega$	Catalog No. $Z_o = 2{,}500\,\Omega$	3DB Bandwidth per cent of F_o ± 9¾	± 19½	Center Frequency F_o (KC)	Per cent Deviation of F_o 8½	15.	Per cent Linearity 0.5	1.0	Catalog No.
FBP-10	FBP-34	V		.4	V		V		DST-10
FBP-11	FBP-35	V		.56	V		V		DST-11
FBP-12	FBP-36	V		.73	V		V		DST-12
FBP-13	FBP-37	V		.96	V		V		DST-13
FBP-14	FBP-38	V		1.3	V		V		DST-14
FBP-15	FBP-39	V		1.7	V		V		DST-15
FBP-16	FBP-40	V		2.3	V		V		DST-16
FBP-17	FBP-41	V		3.0	V		V		DST-17
FBP-18	FBP-42	V		3.9	V		V		DST-18
FBP-19	FBP-43	V		5.4	V		V		DST-19
FBP-20	FBP-44	V		7.35	V		V		DST-20
FBP-21	FBP-45	V		10.5	V		V		DST-21
FBP-22	FBP-46	V		12.3	V		V		DST-22
FBP-23	FBP-47	V		14.5	V		V		DST-23
FBP-24	FBP-48	V		22.0	V		V		DST-24
FBP-25	FBP-49		V	22.0		V		V	DST-29
FBP-26	FBP-50	V		30.0	V		V		DST-25
FBP-27	FBP-51		V	30.0		V		V	DST-30
FBP-28	FBP-52	V		40.0	V		V		DST-26
FBP-29	FBP-53		V	40.0		V		V	DST-31
FBP-30	FBP-54	V		52.5	V		V		DST-27
FBP-31	FBP-55		V	52.5		V		V	DST-32
FBP-32	FBP-56	V		70.0	V		V		DST-28
FBP-33	FBP-57		V	70.0		V		V	DST-33

DISCRIMINATOR LOW PASS FILTERS						
Catalog No.	Center Frequency F_o (cps)	Catalog No.	Center Frequency F_o (cps)	Catalog No.	Center Frequency F_o (cps)	Attenuation
OUTPUT						
LPO-10	6	LPO-19	81	LPO-28	790	.7 DB to 0.5 F_o; 3 DB to 1 F_o; 20 DB to 2 F_o; 30 DB from 2.5 F_o
LPO-11	8	LPO-20	110	LPO-29	900	
LPO-12	11	LPO-21	160	LPO-30	1,050	
LPO-13	14	LPO-22	185	LPO-31	1,200	
LPO-14	20	LPO-23	220	LPO-32	1,600	
LPO-15	25	LPO-24	330	LPO-33	2,100	
LPO-16	35	LPO-25	450	LPO-34	7,200	
LPO-17	45	LPO-26	600	LPO-35	10,000	
LPO-18	60	LPO-27	660			
Characteristic impedance of all = 330Ω						
INPUT						
LPI-10	400	LPI-17	3,000	LPI-23	14,500	.05 DB at 9¾ % F_o; 30 DB at third; 50 DB at fifth Harmonic
LPI-11	560	LPI-18	3,900	LPI-24	22,000	
LPI-12	730	LPI-19	5,400	LPI-25	30,000	
LPI-13	960	LPI-20	7,350	LPI-26	40,000	
LPI-14	1,300	LPI-21	10,500	LPI-27	52,500	
LPI-15	1,700	LPI-22	12,300	LPI-28	70,000	
LPI-16	2,300					
Characteristic impedance of LPI-10 thru 23 = 30,000Ω; of LPI-24 thru 28 = 5,100Ω						

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Circle 103 on Inquiry Card, page 97

WEST COAST FIRM FORMED

Dr. Dean A. Watkins (left) and Dr. H. Richard Johnson are president and vice-president of Watkins-Johnson Company, a new firm established at Palo Alto, Calif., to carry on research, development and manufacture of electron devices. Both are well known for their work in microwave tubes, which is to be a specialty of their company.

New Radar Tracks Missile, Ignores Fall-Away Booster

A new tracking system patented by the government is designed to follow a rocket or missile and disregard booster stages as they fall away.

Designed by Dr. Walter Van B. Roberts of Princeton, N. J., the system uses one transmitter and six receivers, with recorders, along the flight path. The wavelength of the signal is a function of the length of the missile proper, to distinguish it from the shorter carriage or booster.

COMPUTER ASSEMBLY

Transistorized packaged circuits are shown being assembled into computers at Avco Mfg. Corp.'s Research and Advanced Development Div., Lawrence, Mass. Transistorization leads to computers the size of the average office desk.

HELP
for engineers!

STANPAT—the remarkable tri-acetate that is pre-printed with your standard and repetitive blueprint items, easily transferred to your tracings by an adhesive back or front. Relieves time-consuming and tedious detail of re-drawing and re-lettering specification and revision boxes, standard symbols, sub-assemblies, components and cross-sections. Saves hundreds of expensive hours of drafting time and money, frees the engineer for concentration on more creative work.

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* In Operations Edition Only.

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

THE $10 BILLION ELECTRONIC MARKET

. . . and why it takes a monthly to sell it

YOU CAN BE SURE OF THIS When you recommend ELECTRONIC INDUSTRIES . . . a monthly publication frequency is best adapted to the unique character of the electronic market. Here's why:

THE MARKET CHARACTERISTICS

To take away the abstraction from the electronic market, it is only necessary to remember you are selling to an industry based largely on light machinery and hand assembly operations—a "light industry."

It's quite different from the more common industrial markets where capital and engineering investments in "heavy" capital equipment are responsible for most of the value added by manufacture. In "heavy" industries, management decisions on capital spending are necessary in all stages of the product idea-to-final production cycle, and are the key to the salesman's success or failure.

In the "light" electronic technology, however, little capital or engineering is ordinarily invested in production equipment. The value added by manufacture depends principally on the number of engineering-hours invested in the design of the end-product.

This is why engineering decisions—not management capital spending decisions—are the key to the electronic market. Salesmen are finding that the constantly growing complexity of electronic systems is making this more true today than ever before.

One conclusion is inescapable. Electronic technology generates a market structure altogether different from those in aircraft, chemical process, metalworking, and other heavy industries.

The management buying influences which give advertising effectiveness to weekly media in these other engineering fields simply do not exist in the electronic market.

THE MONTHLY

The electronic engineers' need for closer and more exact communication with fellow specialists grows greater with each new technical advance. ELECTRONIC INDUSTRIES, backed by the full resources of the Chilton Company, is therefore expanding its efforts to give him the engineering leadership that only an aggressively edited monthly can supply. Advertisers will continue to have the strong monthly it takes to sell the electronic market.

THE EDITORIAL CONCEPT

Engineering treatment in depth—the first essential of technical communication—is made possible by EI's monthly publication schedule. The electronic engineers' hunger for the ideas of other specialists can be met only if they reach him with the precision and completeness a monthly allows. This is proved by the many hundreds of requests for reprints of feature articles in every issue of ELECTRONIC INDUSTRIES.

THE READER RESPONSE

Reprint Requests—An average of 90 letters per day come in to EI on company letterheads requesting reprints of current articles. Better than 75% of these letters ask for reprints of two or more articles. Many ask for up to 50 reprints for distribution to engineering staffs. One staff assistant devotes full time to nothing but processing reprint requests.

Inquiries—Current issues of ELECTRONIC INDUSTRIES are producing more than 20,000 inquiries for advertisers and manufacturers' literature per issue! This completely contradicts the tradition that magazines of engineering stature are weaker inquiry producers than those edited with inquiries as their primary purpose. Since EI has at least 50% greater electronic O.E.M. circulation than all but the Association sponsored publication, few advertisers will question the relative quality of these inquiries.

MARKETING AIDS

Market Research—Results of ELECTRONIC INDUSTRIES census of electronic manufacturers will be available to advertisers by May, 1958. When used in conjunction with the publisher's IBM facilities, this census data will be a powerful tool for market research.

Starch Readership Service—EI is the only electronic publication to offer Starch advertising readership studies. Six issues are scheduled for Starch Studies in 1958—January, March, April, July, October and December.

Copywriting Suggestions—A Series of bulletins entitled "Copywriting Suggestions for Advertisers to the Electronic Industries" will be sent on request. These bulletins have been widely commended by the advertising fraternity in the electronic field.

JUNE DIRECTORY ISSUE

High speed electronic data processing of questionnaire data will add new dimensions to ELECTRONIC INDUSTRIES annual June Directory Issue in 1958. This directory will list more products than ever before. More precise distinctions will be made between similar products. Its extra usability will quickly show up in day-to-day use. It will create a 12-month audience for all advertisers in this advanced directory.

Plan now for a spread, an insert, or multiple pages. Regular rates apply (this is not a 13th, or extra cost issue).

EI has a larger electronic O.E.M. circulation than any other publication

ELECTRONIC INDUSTRIES

Chilton Company Executive Offices: 56th & Chestnut Sts., Phila. 39, Pa.

New York 17
Menard Doswell
Gerald Pelissier
100 E. 42nd St.
OXford 7-3400

Chicago 1
George Felt
360 N. Michigan Ave.
RAndolph 6-2166

San Francisco 3
Don May
1355 Market St.
UNderhill 1-9737

Philadelphia 39
Joseph Drucker
56th & Chestnut Sts.
SHerwood 8-2000

Tulsa
Hal Mott
Petroleum Bldg.
LUther 4-1769

Cleveland 15
Shelby A. McMillion
930 Kieth Bldg.
SUperior 1-2860

Los Angeles 57
B. Wesley Olson
198 S. Alvarado St.
DUnkirk 7-4337

Dallas 1
John Sangston
909 Mercantile Securities Bldg.
Riverside 7-1732

For specific market information contact your EI Regional Sales Manager

THE BIRTH OF RADAR

According to an old Croatian fable, the first experimental radar station was installed 102,000 years ago last Thursday by a tribe of Cro-Magnons. But no sooner had the station been erected than a dinosaur appeared on the scene and gulped down everyone in sight—everyone but one badly frightened survivor.

"Tell the truth, man," the dinosaur said, "or I'll make Filet Cro-Magnon out of you. What is this mess of bones and stones you have here?"

"Ra-ra-radar," was the weak reply.

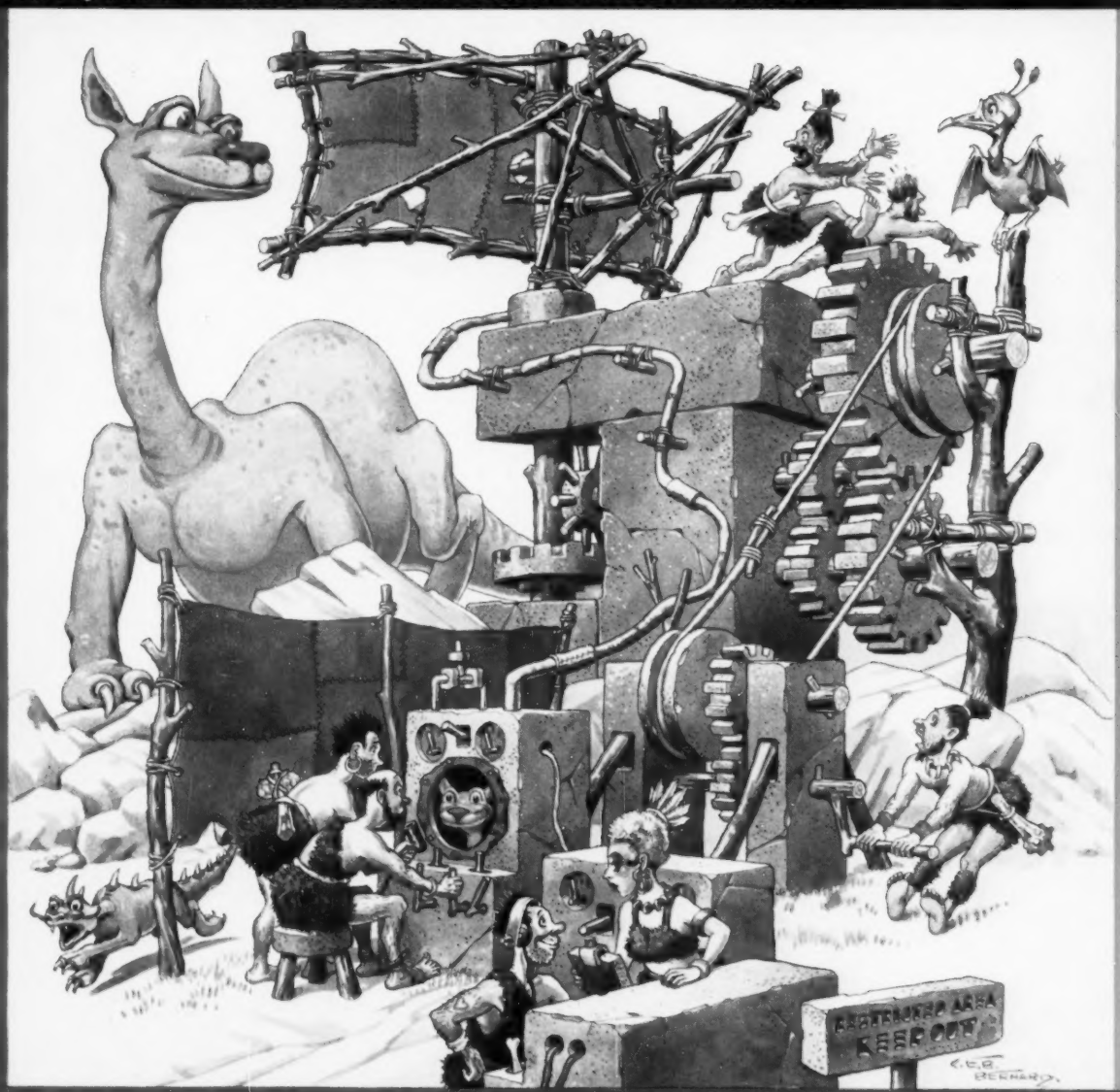
"Tell me another one," the dinosaur snorted. "If this is radar, I'm a ring-tailed brontosaurus. Does it use Bomac tubes?"*

"No . . . but . . ."

"That does it," the dinosaur said. "Whoever heard of a radar set without Bomac tubes?" He opened his mouth wide.

"Whoever heard of a talking dinosaur?" the man asked. But he was too far inside the dinosaur to hear the answer.

No. 1 of a series . . . BOMAC LOOKS AT RADAR THROUGH THE AGES



* *Bomac makes the finest microwave tubes and components since the birth of radar*

Bomac LABORATORIES, INC.
Salem Road, Beverly, Massachusetts

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; hydrogen thyratrons; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

Offices in major cities—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Toronto • **Export:** Maurice I. Parisier, 1860 Broadway, New York City.

Circle 98 on Inquiry Card, page 97

Looking for the right transistor?

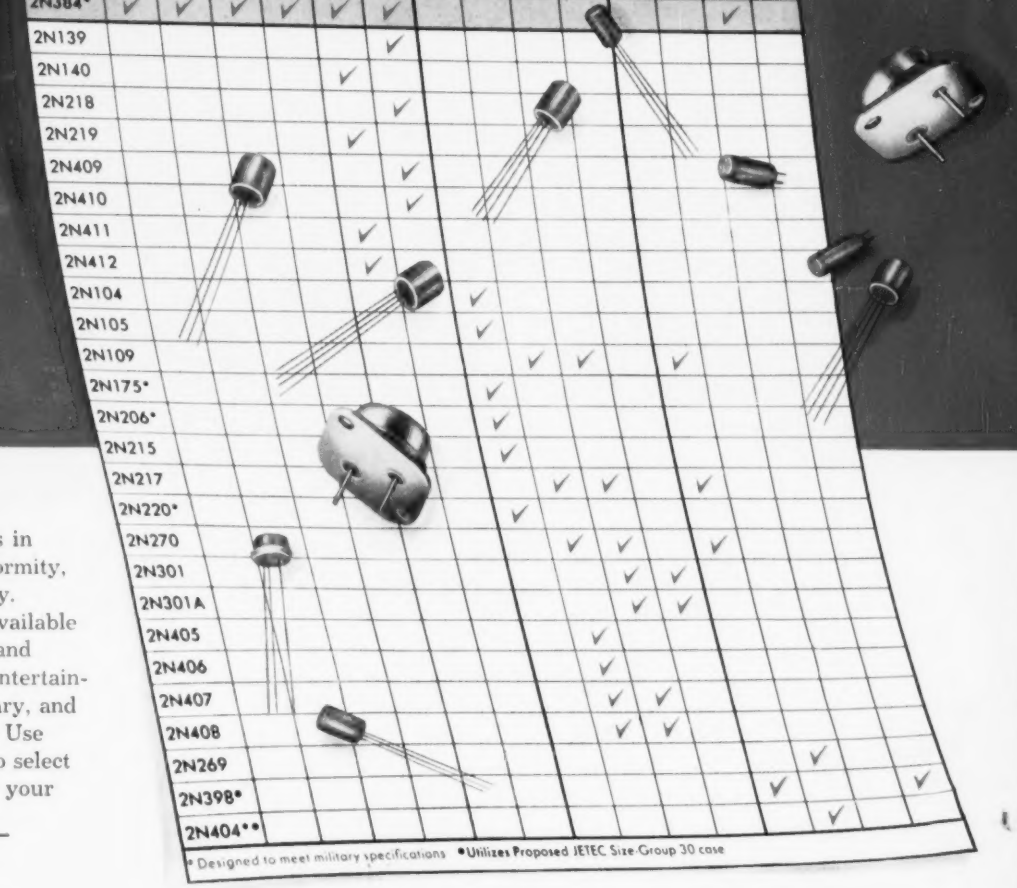
. . . check this list of

RCA TRANSISTORS!

RCA TYPE	CLASS OF SERVICE													
	Radio Frequency						Audio Frequency				Switching			
							CLASS A		Classes A and B		LOW LEVEL			
	VHF Amplifier	HF Amplifier	Mixer	Oscillator	Converter	IF Amplifier	Small-Signal	Driver	Large-Signal	Power	Low-Speed	Medium-Speed	High-Speed	High-Voltage
2N247		✓	✓	✓	✓	✓							✓	
2N274*		✓	✓	✓	✓	✓							✓	
2N370		✓												
2N371			✓											
2N372				✓										
2N384*	✓	✓	✓	✓	✓	✓							✓	
2N139						✓								
2N140					✓									
2N218						✓								
2N219					✓									
2N409						✓								
2N410						✓								
2N411					✓									
2N412					✓									
2N104								✓						
2N105								✓						
2N109									✓	✓		✓		
2N175*								✓						
2N206*								✓						
2N215								✓						
2N217									✓	✓			✓	
2N220*								✓						
2N270									✓	✓			✓	
2N301										✓	✓	✓		
2N301A										✓	✓	✓		
2N405										✓				
2N406										✓				
2N407										✓	✓	✓		
2N408										✓	✓	✓		
2N269													✓	✓
2N398*													✓	✓
2N404**														✓

DRIFT TYPES

* Designed to meet military specifications • Utilizes Proposed JETEC Size-Group 30 case



From dc to vhf, RCA Transistors are leaders in quality, electrical uniformity, long life, and reliability. RCA Transistors are available for use in RF, IF, AF, and Switching service in entertainment, industrial, military, and computer applications. Use this handy check-list to select the *right* transistor for your required service.

For a discussion of types best suited to your requirements, contact your Field Representative at the RCA District Office nearest you. For technical data on specific RCA Transistors, write to RCA Commercial Engineering, Section B-50-NN-2, Somerville, N. J.

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Midwest: Suite 1181, Merchandise Mart Plaza, Chicago, Ill., WHitehall 4-2900
West: 6355 E. Washington Blvd., Los Angeles, Calif., RAymond 3-8361
Gov't: 224 N. Wilkinson Street, Dayton, Ohio; HEmlock 5585
1625 "K" Street, N. W., Washington, D. C., DIstrict 7-1260

RADIO CORPORATION OF AMERICA
Semiconductor Division — **Somerville, N. J.**